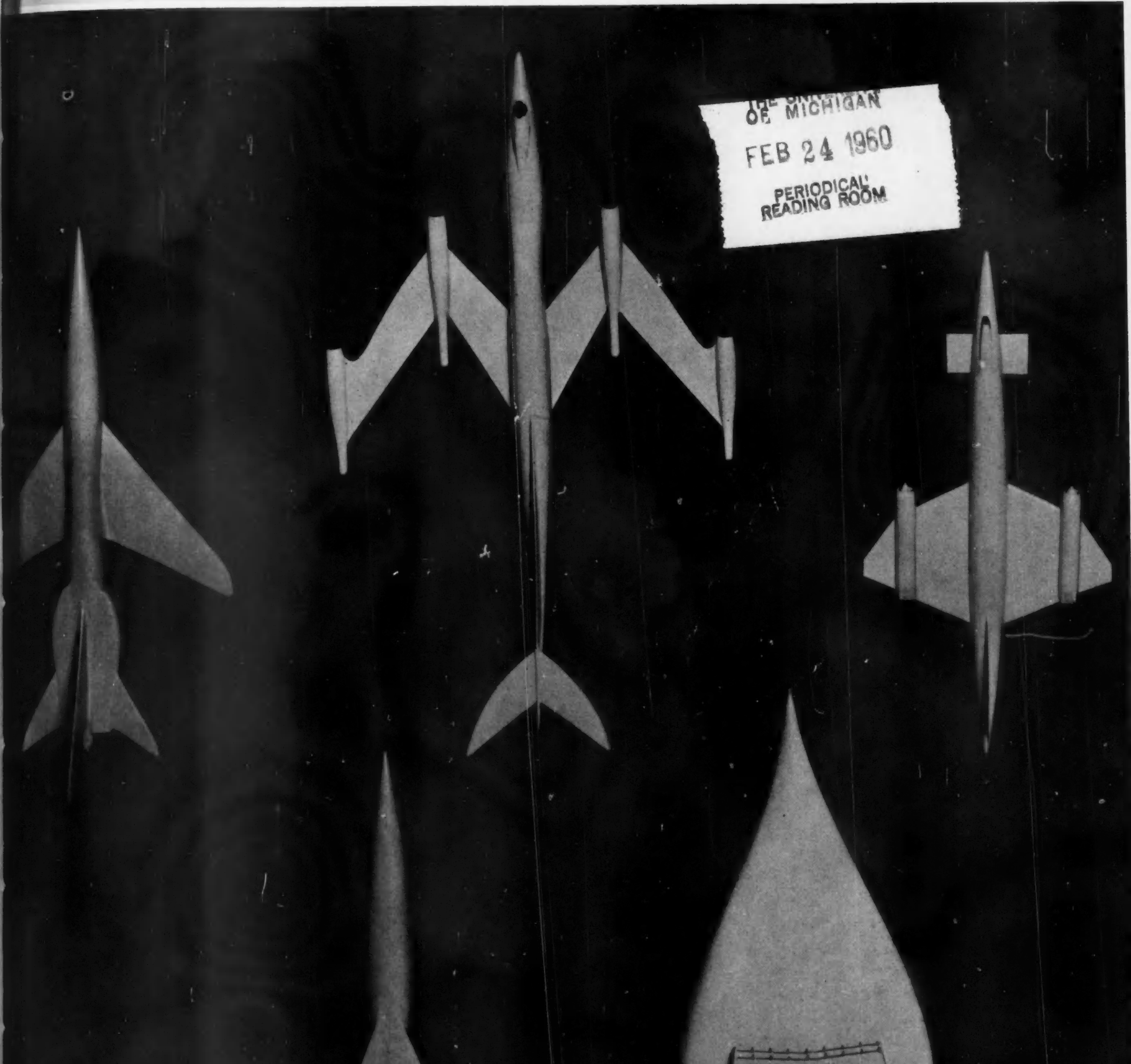
DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

FEBRUARY 1960

2/6



In next month's issue of

DISCOVERY

The Progress of Science in the Sahara

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Hydroponics in the Sahara by Prof. Ghouard and Mme Renaud, French Government Scientific Department

Ecology in Africa from the Sudan to the Transvaal by Prof. John Phillips, University College of Ghana

Frank Horrabin's book, "An Atlas of Africa", reviewed by an eminent contributor

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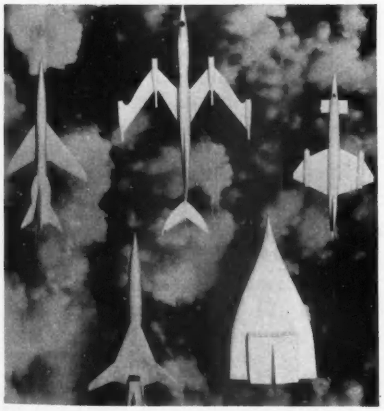

Five models of what future aircraft might look like. These are based on scientific ideas and form the last sequence of the Shell trilogy of films "High-Speed Flight" (See p. 88).

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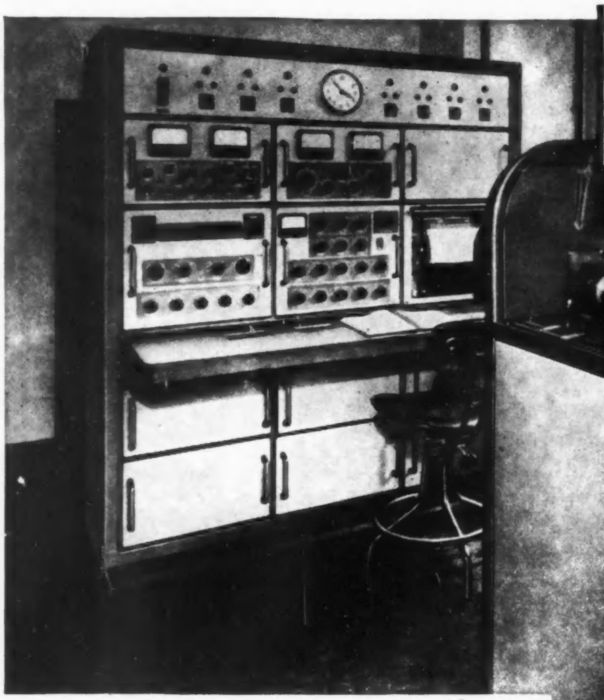

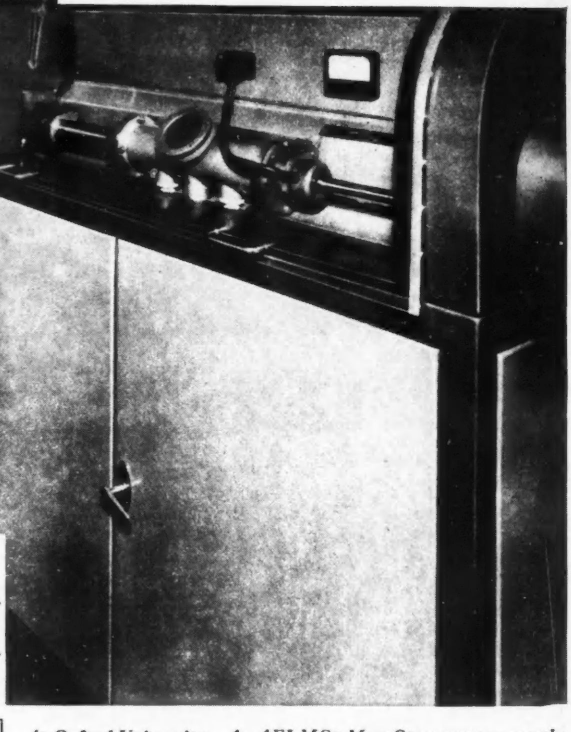

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William E. Dick died suddenly on January 12, 1960.

WILLIAM ERNEST DICK,

B.Sc., F.L.S.

Editor of* DISCOVERY *1945–56

That DISCOVERY is today one of the most successful scientific journals, that it circulates throughout the world, that the most eminent scientists from all parts of the earth are regularly contributing, is mainly due to Dick, its editor during the crucial years of 1945 to 1956. DISCOVERY was founded in 1920 but ceased publication in March 1940. It was started again in January 1943 by its present publishers, and Bill Dick soon became a regular contributor. It was early in 1945 that he formally took on the editorship. That he brought DISCOVERY to the high academic level, and that he gave it a universality of coverage which we still maintain will always be his greatest contribution to the progress and application of science, to which he so earnestly devoted his whole life. Every editor needs friends to help him in his task to create, and all who knew Dick will at this hour think of him again as what he was: a scientist, utterly devoted to the ideal that science must be used for the benefit of mankind. Dick's many signed articles, and his monthly writings in "The Progress of Science", all had the same aim, and it is our present editorial policy to perpetuate and to bring to fulfilment this same basic thought: the progress of mankind through the benefits of science.

He was born on July 12, 1914, and was educated at King's School, Wimbledon, where he took a State scholarship at the age of fifteen to Imperial College to read Biology. He left with his degree uncompleted, forfeited his scholarship, and joined the Auxiliary Fire Service at the outbreak of war. He served as a non-commissioned officer in the British Expeditionary Force at the Royal Army Service Corps Headquarters and later transferred to one of the camouflage units of the Royal Engineers. He then became a reporter, and was working full time on the *South Western Star* when he went to the old Battersea Polytechnic and took his degree in Botany and Geology. He was very soon afterwards elected to the Fellowship of the Linnean Society of London. For a brief period he served on the editorial staff of the *Chemical Age*, before he came to DISCOVERY in a full-time capacity in September 1944. Trained as a biologist, Dick maintained his professional interests, especially in the British flowering plants, of which he was exceptionally knowledgeable, and in summer he was seldom seen without a buttonhole of his own growing. In addition to his contributions to DISCOVERY, the latest of which was only published in the November issue of 1959, his articles in other scientific journals and his books will live for many years to come. In 1946 Simpkin Marshall published "Science and the Welfare of Mankind", written in conjunction with I. B. N. Evans; in 1951 he wrote "The Story of Energy" for the Bureau of Current Affairs; and in 1957 Butterworth brought out "Atomic Energy in Agriculture". Perhaps the best known of his articles was "Science and the Press", written for the journal *Impact* in 1954.

His was not an easy life, and in coping with frequent ill health he was immensely helped by the encouragement of his wife, Esther, whom he married in May 1940.

Dick brought much more to his work than a wide knowledge of the various realms of science. He was primarily a journalist—a reporter of everyday life—having been engaged in the day-to-day work of both provincial and national newspapers. At one time he considered joining the full-time staff of a Fleet Street paper, but his shyness deterred him from this venture. This experience and his training for getting "news stories" were the foundation on which his work in the field of science-writing was built. Dick was not only a gifted interpreter of science for the layman but also had the rare ability of presenting scientific developments in "popular" terms without sacrifice of scientific accuracy.

In the early days of DISCOVERY, his was, in fact, the hand that guided the editorial content. He took over "The Progress of Science" from David S. Evans when he left for South Africa, and by early 1945 it was clear that the editorial future of DISCOVERY was safe in the capable hands of Dick, and he assumed full editorial control.

They were years of great excitement. Peace came to a war-worn country. Britain was eager for new ideas. Mr Butler's Education Act was passing through Parliament and being hailed by most far-seeing Education Authorities. In this period, one factor was pre-eminent. The impact of science on the post-war way of life in this and other countries was immeasurable. It was inspiring; it was an opportunity that Dick grasped firmly.

The editorial policy of DISCOVERY grew wider as its authority became more and more recognised. Eminent scientists, from all countries and of all disciplines, first became contributors, then friends of the magazine. Their articles were eagerly read all over the world. Microfilms of the magazine were flown to China. A request for a Spanish edition was made and met. The formative years were long, arduous, but very satisfying for him.

As Dick aptly wrote on the tenth anniversary of his editorship: "the editing of DISCOVERY is a never-ending struggle to accommodate a quart in a pint pot". And the tributes printed in the issue of January 1954 form even now, six years later, a true appraisal and lasting memorial to the best years of his life's work.

TOO MANY PEOPLE?

Prof. Medawar's first Reith Lecture blew a welcome wind of common sense through a field which has suffered much in recent years from prejudice and ill considered pronouncements. What useful comment can really be made on the world population problem?

On the one hand we have a group of liberal humanists (not all of them scientists) telling us that unless we do something quickly to control the present explosive increase in the population of the world we shall be faced very soon by an immense disaster. On this view the problem of population is more pressing than all others and the sands are fast running out; all attempts to spread the benefits of medicine and hygiene to the under-developed countries, all efforts by these countries to raise their standard of living, are doomed to failure by the relentless increase in the number of mouths to feed. The more people we keep alive today the more victims there will be for the inevitable famine when it comes, and the sooner it will come.

On the other hand we see an unusual alliance of Marxists and Catholics, who insist that the problem does not exist, or, if it does, that it can best be solved by individual abstinence. The Chinese say that the problem is a purely capitalist one, arising from the inability of capitalist economy to expand quickly enough to keep pace with the population. One even hears the suggestion that the whole affair is a scare raised by a Western world desperate to maintain its superiority in face of the growing power of the East.

Faced with a disagreement of this magnitude, the wise men will take a fresh look at the facts.

First, how fast is population increasing? Recent United Nations statistics show a rate of increase for the whole world (1953–7) of 1·6% per year, a rate which, if maintained, would double the population in forty-three years. Taking the continents as a whole, the highest rate of increase is found in South America (2·3%), followed by Australasia (2·2%). Europe is much the lowest, with 0·7%. Among the larger individual countries, China and Brazil are outstanding with 2·4%. The United States is above the average (1·8%); India (1·3%), and Japan (1·2%) well below.

How do these figures compare with the statistics of food production? In the ten years from 1948 to 1957 world production (by weight) of food increased by 23%, or an annual average of just over 2%. (This figure excludes China and the U.S.S.R., but there can be little doubt that their rate of increase was substantially higher.)

On these figures the situation appears to be in hand. Food production is increasing faster than the population and no world-wide famine is imminent. Is the problem then one of distribution? Is the increase in consumption of food confined to those countries which, by world standards, already have enough? The answer is no. Nearly all countries for which statistics are available have seen an increase in calorie consumption *per head* since 1950. India and Japan are examples.

It seems fair to conclude that we are not faced with immediate disaster. The future depends, however, on the maintenance, or preferably the improvement, of the present rate of increase of food production. The world level of agricultural productivity today is extremely low, but at least this means there is immense room for improvement. The problem is less one of research in science and technology than of persuading the world's farmers to adopt the techniques already known and used in the more productive countries. There are very few governments which are not aware of this problem. As long as they do not relax their efforts and if there is no war, we should be safe enough from world-wide famine for the next few decades. After all, 2% is a very modest annual increase.

But further ahead the outlook is less attractive. Most of us feel that there are already far too many people for comfort in the British Isles. Yet at the present rate of population increase the whole world will be as crowded as we are in less than 150 years. This is a theoretical figure, which assumes dense populations on the Himalayas and in the Sahara, as everywhere else. Obviously, long before then day-to-day life is going to become acutely inconvenient for a large number of people, whether or not the problem of food supply is solved. Even if it is argued that such inconvenience is not a serious problem, that we get along well enough in Britain and so why should not the whole world be as thickly populated—even so, the problem must become serious some time. In 300 years the whole world will be as crowded as London; in 700 there will just be room to stand up. Unless human populations begin voluntarily to restrict themselves (which is possible but seems unlikely) some day there will have to be some form of control imposed from outside.

Yet it may well be asked whether there is anything to be gained by arguing about the remote future. Prof. Medawar showed how even twenty-year predictions can go hopelessly wrong. If we keep our eyes on the next decade or two we see that, except in a few countries like Japan, Algeria, Puerto Rico, and the West Indies, and to a lesser extent India, the problem of population is not at present a pressing one, and a vigorous policy of agricultural development offers more immediate hope than a crash programme to find a convenient cheap contraceptive. But to deny that a problem is pressing is not to deny that there is a problem. Some day the rise in the world's population must be stopped, and the sooner the better. It is good that some people are concerned about the matter already. But they might get an even better audience if they did not try to persuade the world that all its other problems were less urgent.

Perhaps one day, when the desperate attempt just to slow down the population increase has met with some success, it may be possible to begin the far more interesting task of deciding what level of population we really want to maintain. Do we want a thickly populated country like modern England, with the advantages of a huge and varied industry, mass markets, and a great capital city with a lively cultural life? Or would we prefer an England like Norway, where every family can find an unoccupied beach, where the countryside is never more than twenty minutes away, where travel is even a pleasure and the children can roam where they like? It is a difficult question, but at least it would be nice to have the choice.

Amama, the new food to combat protein malnutrition, is now being produced by Glaxo Laboratories (Nigeria) Ltd at Apapa, near Lagos. Before local production began the first batches were prepared at Greenford for despatch to Nigeria. This picture, taken in England, shows the mixing plant. The larger machine (*foreground*) is mixing the final Amama, the smaller machine is being charged preparatory to making a pre-mix.

(By courtesy of Glaxo Laboratories Ltd)

AMAMA: A NEW PROTEIN FOOD FOR NIGERIA

A new protein food called Amama is now being marketed in Nigeria to combat the high death-rate among Nigerian children due to protein deficiency. This product, a pink powder which is added to a child's food, consists of groundnut flour to which carefully judged proportions of dried yeast, milk casein, sugar, five minerals and seven vitamins have been added. Amama is manufactured at Apapa by Glaxo Laboratories (Nigeria) Ltd, a subsidiary of Glaxo Laboratories Ltd of Greenford, England.

The age group liable to protein deficiency, or *kwashiorkor* as it is known in many parts of the world, is from about six months to school age. *Kwashiorkor* can develop rapidly and is an extremely distressing disease with a high death-rate. At the acute stage treatment is difficult, for not only are the children very ill, but they also suffer from loss of appetite. Because of these two factors, a method of prevention is important. The disease can easily be prevented if children receive regular supplies of a protein-rich supplement with their normal diet.

The seriousness of this problem was discussed by the Nigerian medical profession at the Nutritional Conference at Ibadan in September 1957, when it was shown that protein is particularly deficient in the diet of the people of Southern Nigeria where the staple foods are cassava and yams. In some areas there is also a deficiency of vitamins and minerals.

In 1955 Dr W. F. J. Cuthbertson, then working at University College, Ibadan (Nigeria), saw the extent of the misery caused by protein deficiency in West African children. On his return to London he and his team at Glaxo began work on finding a formula for a low-cost supplement, using groundnuts as a base.

Amama is intended to be given with the normal diet, 1 oz. (four scoopfuls) per day being recommended. The supplement is added to food until the child is six or seven years old. Glaxo decided that the price must be kept down to the absolute minimum so that everyone could afford to buy the product. Amama, in an 8 oz., eight-day packet retails for about 1*s.* 6*d.*, a price that is within the range of the average Nigerian.

To assist in the educational campaign, several vans staffed by trained African teams, tour Nigeria to bring the news of the project to the population. Already in these areas there has been considerable interest in Amama as a result of extensive trials by hospitals. The publicity vans travel round the towns and the outlying villages giving demonstrations. In addition a short film, featuring Amama, with an all-Nigerian cast, is being shown in the cinemas and posters are appearing on station, market, and village sites throughout the areas.

For generations the ravages of *kwashiorkor* have afflicted the population, especially those in the Western Region. The high mortality, the untold misery and pain afflicting the victims, has been a number one problem for social workers in Nigeria. Now comes the hope, shared by the Nigerian government and its child health specialists, that protein malnutrition in Nigeria will at last be defeated and that as a result Nigeria's economic self-sufficiency will come one step nearer.

ELECTRONICS FOR WINTER OLYMPICS

Squaw Valley, California, 6200 ft. high, in the Sierra Nevada Mountains, is the perfect setting for the Eighth Winter Olympic Games, beginning in February 1960. Half a mile wide and two miles long, it lies encircled among pine-studded peaks rising to 9000 ft., down whose slopes on February 18, a torch-bearing skier will fly to light the Olympic Flame, setting off the new winter series.

A classic international gathering of the world's finest athletes, the Olympic Games date back to 776 B.C. when Greek champions gathered at Olympia to honour Zeus, in the presence of a handful of onlookers. The audience at Olympia numbered only a fraction of the millions throughout the world who are able, in the 20th century, to follow the progress of the Games by radio, television, and the Press.

At Squaw Valley, for the first time in Olympic history, modern scientific methods will make available to the Press, and through them to the world-wide audience, immediate, up-to-the-minute information on scoring and the standing of competitors.

Winter Olympic scoring procedures are the most complex of any athletic event, involving form and style as well as speed and distance. Scores have often not been available for as long as five hours after an event. At Squaw Valley an Olympic Data Processing Centre, housing an electronic computer, will produce these results in seconds and minutes rather than hours. This new departure will also benefit athletes, numbering over 1000 from more than thirty countries, who will know their own achievements and those of their competitors almost immediately. Individual performances can thus be geared accordingly and strategies changed.

The Data Processing Centre, linked by over one million feet of communication cable to every major performance point, has been staffed by International Business Machines Corporation and equipped, without charge, with an IBM RAMAC 305 computer.

The initials RAMAC stand for Random Access Method of Accounting and Control, a new term in automatic data processing which signifies a considerable development since the advent of the electronic computer.

This is a machine, already widely used in Britain and on the Continent, and even more widely in the United States, which is able to process every aspect of a transaction simultaneously. Its implications in industry are far-reaching in terms of economy of record-keeping. Particularly so in large organisations where RAMAC will, for example, accept an

An electrical timing apparatus is located at the finishing line for the Alpine events, where crowds of spectators will gather to cheer home the world's top skiers. In the background is the Squaw Valley Lodge, a popular spot for relaxing and refreshments.

order from a customer and, simultaneously, ascertain that the order can be filled, print out any necessary requisitions for new stock, debit the customer's account, credit stock account, calculate and print out the invoice and, when required, deliver an updated statement of the customer's account and an updated stock inventory.

The RAMAC computer includes a magnetic memory which looks like a stack of over-sized gramophone records. In the memory of the Squaw Valley RAMAC will be stored, in the form of magnetic spots, the equivalent of a million words of information and instructions concerning the scoring procedure exactly as specified by the rules of the governing bodies of each of the twenty-six separate events.

During each event the performance of every competitor will be telephoned to the Data Processing Centre and fed into the computer, which will extract the correct set of instructions from its memory, make all necessary calculations, process and store the competitor's result. As each competitor finishes, his score will be compared with all other scores in that event. The RAMAC will then print out, on high-speed printers, the contestant's name, starting number, country, points total, and place among his competitors. This information will be relayed immediately to officials, the international Press, and the public scoreboards. At the same time, the standings of all contestants will be automatically updated so that they are kept current throughout.

The RAMAC will score, simultaneously, as many events as necessary, whether they are speed or figure-skating competitions or the various ski events, slalom, downhill, jumping, or cross-country racing.

In addition to scoring the Winter Olympics the RAMAC will print out starting orders and various record-keeping forms, and a certificate for each competitor, indicating his official performance, as a permanent souvenir. Throughout the Games, background information on any of the competitors, such as biographical details, will be available on request at the touch of a button. All information will be produced in English and French, the official languages of the Games.

This historic contribution by International Business Machines to the 1960 Winter Olympics is one more example of the revolution in record-keeping which has been brought about in the 20th century by electronic information machines.

The IBM RAMAC is kept busy computing each competitor's score and determining his placing. Results are automatically printed out by the computer and relayed by telephone to the spectator area to be indicated on the official scoreboards. While the RAMAC prints out the results, it simultaneously cuts a tape which is fed into a teletype system to be transmitted by the Press.

ICSU PLANS AHEAD

The Executive Board of the International Council of Scientific Unions (ICSU), meeting at its headquarters in The Hague towards the end of 1959, made at least three decisions of some importance to world science.

The affairs of the IGY 1957–8, so ably conducted by its ICSU-appointed leaders (Sydney Chapman of College Alaska, and Marcel Nicolet of Brussels) were finally wound up. Nevertheless, world-wide co-operation in Geophysics, which during the IGY had become an integral part of the daily routine of working scientists in more than sixty countries, must be allowed to continue; therefore the Board created a new Steering Committee for Co-operation in Geophysics and Related Sciences (CIG, from Comité International de Géophysique). The Chairman of the Committee will be Academician V. Beloussov, distinguished geophysicist of the U.S.S.R., and Georges Laclavère of Paris will be Secretary.

CIG's first task will be to organise a World Magnetic Survey in 1962–3, the next period of minimum solar activity: under a quiet sun, a network of so-called "magnetic indices" can be plotted from point to point over the entire surface of the globe, without interruption from the terrestrial magnetic storms which accompany major eruptions on the sun's disc.

During 1962–3, too, the physical oceanography, animal ecology, and meteorology of the Indian Ocean will be investigated. This research will be carried out by the Special Committee for Oceanic Research (SCOR) (led by Roger Revelle of the Scripps Oceanographic Institution at La Jolla), an ICSU committee. Less is known about the Indian Ocean away from the much-used sea-lanes than about the surface of the Moon. Moreover, it is the ideal ocean area in which to learn more about the interplay of wind and wave in the creation of surface currents: for the wind system above the Indian Ocean reverses itself completely every six months, in tune with the monsoon cycle. And the wealth of animal life in the Indian Ocean, only dimly assessed by the pioneer work of the Danish oceanographic research vessel *Galatea* in 1951–2, must now be thoroughly examined on behalf of the under-developed countries bordering upon it.

Here ICSU links up closely with the UN Agencies UNESCO and FAO, both of which have a special duty—the one sociological, the other industrial—to reap the harvest of the Indian Ocean for the betterment of living conditions in those countries.

Finally comes Man's greatest adventure to date in the exploration of his environment—Space Research. In this area, too, firm decisions were arrived at by the Executive Board, under the chairmanship of the President of ICSU, Sir Rudolph Peters.

An already well-known organ of the ICSU, COSPAR, held a full meeting of its Executive Committee in the Netherlands early in November, under the chairmanship of Prof. H. C. van de Hulst of the Sterrewacht Leiden. The immediate task of the committee was to arrive at a finalised text of the COSPAR charter, which will ensure a just balance in membership, both of the scientific disciplines involved in space research, and of the countries which are either actually launching space-vehicles, or assembling scientific instead of lethal "war-heads", to be carried in the space rockets of the U.S.A. or the U.S.S.R., or in tracking the earth satellites and space probes launched in the U.S.A., the U.S.S.R.—or perhaps in the not too far distant future, from within the Commonwealth.

This job of internal organisation accomplished, COSPAR can proceed, with the full confidence of world science, in its sponsorship of the first World Scientific Symposium on Space Research, recently held in Nice.

ICSU has in fact come of age as a world organisation. It can therefore now enter into full adult partnership with UNESCO. In this regard, ICSU was greatly encouraged by the warm and statesmanlike approach to the problem of really effective co-operation between the two organisations which was made at The Hague meeting by Prof. Victor Kovda, recently appointed Director of the Natural Sciences Department of UNESCO.

YORK WANTS A UNIVERSITY

York has a strong and unique chance of becoming the seat of a university within the next four or five years. Because of the national demand for university places to meet the "bulge" of the mid-1960's, the University Grants Committee is considering the possible establishment of new universities. The chairman of the Committee (Sir Keith Murray) paid an informal visit to York during the summer of 1959 to see what the city has to offer.

The movement for a university is chiefly the outcome of the work of York Academic Trust, an independent body of local citizens and people closely connected with York who have been working towards this end for the last ten years. Within this period they have raised some £65,000 without calling either on government or on local authority support, and have established two mainly post-graduate institutes—the Borthwick Institute of Historical Research and the Institute of Advanced Architectural Studies.

The Borthwick Institute was established in 1953. It contains the archives of the archdiocese of York, Church Commissioners' records, and other documents. There are facilities for research (with or without supervision), and short courses are held. Scholars from all parts of the country work there, with others from abroad (chiefly the U.S.).

The Architectural Institute, also founded in 1953, is unique in being the only organisation of its kind in the country which provides courses at post-graduate level for members of the architectural and allied professions. This pioneer venture has attracted the support of virtually all the national societies and official bodies concerned with architecture and building.

The Academic Trust also holds annual courses for overseas students (in association with the British Council) and owns St Anthony's Press, which issues the publications of the two Institutes. Since it was established in 1952 it has produced five books, fifteen booklets, nine bulletins, and the Trust's annual reports.

The Trust is at present engaged (jointly with York Corporation and the national associations concerned) in a scheme for the establishment of a third institute for senior officers in local government.

York's claim to a university is strong in all respects. The city has a background of history and culture—in fact some-

Heslington Hall and its grounds, suggested as part of the site for York's proposed University.
(By courtesy of the Yorkshire Evening Press)

thing of the ethos of Oxford and Cambridge—but combined with the vigorous life of a modern community so that consciousness of both the present and the past is equally balanced. There is too a magnificent site at Heslington, much of it already landscaped and containing within its grounds a large historic house, only 1½ miles from the centre of the city. The purchase of 150 acres to meet initial requirements is contemplated, but there is virtually unlimited acreage which could probably be made available for subsequent expansion.

There are of course three universities in Yorkshire already, but the sponsors believe that this fact is no longer an obstacle to the claim of York itself, since the university to be established there would be primarily a non-regional one, drawing students not only from all parts of the British Isles but, indeed, from all parts of the English-speaking world.

The university which the Trust visualises for York would provide teaching and research facilities for approximately equal numbers of students in three faculties of arts, science, and economics and social science.

Basic subjects to be covered by these faculties might be:

Arts: English language and literature, history, modern languages.
Science: mathematics, physics, chemistry, biology.
Economics and social sciences: economics, public administration, social administration, business administration, transport.

There are also certain subjects and types of student for whom the sponsors would like to make special provision:

(*a*) Overseas students: the number of overseas students continues to increase (11% of the total in 1957). York is a microcosm of the British way of life and, as the York Academic Trust's existing courses have shown, has much to offer them, and particularly to students from the Commonwealth who will later be leaders of their countries when they attain self-government, and replace more primitive ways of life by new systems modelled on Western democracy and technology.

(*b*) Administration in all its forms: the increasing complexity and spread of bureaucracy in modern life calls for constant research and inquiry into administration and theory of government, so that what originated as a necessity of organised living may not degenerate into a cumbersome stranglehold and become an end in itself.

(*c*) Local government, industrial and social welfare (particularly in view of the pioneer work carried out in York by Seebohm Rowntree), business administration, transport and communications, touch us all in our daily lives and should be made the subject of special study.

As regards financial resources, which are, of course, one of the key factors in any application to the University Grants Committee, York is better placed than any other city with university aspirations to attract funds from private sources, thereby relieving pressure on the public purse and strengthening the independence so vital to an academic institution. Particular mention should be made here of the two Rowntree Trusts whose headquarters are in York. Of these the Joseph Rowntree Social Service Trust has largely financed the activities of the Academic Trust since its earliest days, while the Joseph Rowntree Memorial Trust has recently come forward with a magnificent offer of £100,000 towards the general establishment of the university, and has supplemented this by indicating that it would be willing to give "substantial additional support" for activities in the field of social science. York Corporation is at present considering the scale at which it will support the university, and further announcements of support from other sources are expected to be made known within the next few months.

Since the first public announcement that York intends to lay its scheme before the University Grants Committee, there has been considerable local and national enthusiasm for the project. Favourable comments were made by many of the distinguished scholars who visited York for the British Association meeting during September 1959. Sir

James Gray, its president, said: "York has all the virtues and attributes of a great university city."

OCEANOGRAPHY: THE EARTH'S LAST FRONTIER

The first International Oceanographic Congress recently ended its two-week session at United Nations Headquarters in New York with the assurance that oceanography has passed from the phase of blind exploration and accidental discovery into a full-fledged science bent on investigating systematically the last great frontier of this planet—the ocean depths.

The Congress, which drew over 1100 scientists from some forty-five nations, was convened by the American Association for the Advancement of Science and was co-sponsored by UNESCO—on whose report the following is based—and the Special Committee for Oceanic Research of the International Council of Scientific Unions (ICSU).

For two weeks specialists representing the most diverse disciplines—geologists, palaeontologists, hydrographers, geophysicists and geochemists, meteorologists, nuclear physicists, physical chemists, biochemists, botanists, zoologists, and many others—met together to exchange information on research in their respective fields, and also for a sort of cross-fertilisation of work in different fields. Oceanography, the Congress proved, is not only a science but the focus of many sciences.

During the meeting, plans for a major international research project in the Indian Ocean were announced by ICSU's Special Committee on Oceanic Research for the years 1960 to 1964. This plan, somewhat on the model of the International Geophysical Year, provides for a thorough, co-ordinated study of the Indian Ocean by an international fleet of research vessels to be provided by Australia, France, India, Japan, South Africa, the U.S.S.R., the United Kingdom, and the United States, and perhaps by the German Federal Republic and Norway.

The Indian Ocean, reaching from Indonesia to South Africa, touches many lands whose present need of food will increase with growing populations. It is of special scientific interest because twice a year the monsoons reverse its ocean currents and thus shift the locations of the up-swelling waters from below that are rich in the basic materials for the nutrition of fish. In addition, the ocean is thought to be crossed by a submerged mountain ridge that curves from below the tip of Africa to the Pacific, passing between Australia and Antarctica but branching to send a ridge also northward to the Red Sea.

Another project outlined during the Congress may help to answer questions on the age of the Earth's crust and the original formation of the oceans. The proposal (which the U.S. National Academy of Science and the National Research Council consider completely feasible) is to bore a hole all the way through the crust of the earth, where it is thinnest at the sea bottom, about 18,000 ft. below sea-level, down to a depth of 31,000 ft., where the lighter crystal rocks end and the Earth's "mantle" begins. Two years will be required for the experimental drilling of more shallow holes and for the development of special equipment. Then a new deep drilling vessel will be built and at least two more years will be needed to reach the dense hot rock of the mantle that comprises the main mass of the Earth. (See p. 62.)

A third important development was revealed at the Congress by Dr Y. Miyake of Tokyo in a report for a working group of ICSU's Special Committee for Oceanic Research. This called for a world-wide study of the radioactivity of the ocean waters to determine the effect of the submarine disposal of radio-waste products from nuclear reactors and laboratories.

The report recommended that the International Union of Geodesy and Geophysics develop standard methods for the radioactive analysis of sea-water and prepare a manual that would permit uniform and standard procedures by all nations. It also asked for the establishment of a world-wide network of testing stations on the shores of maritime countries and on weather ships and whaling ships at sea which would make a continuous record of the radioactivity and its changes at a large number of points on all the oceans.

A further recommendation was that the International Atomic Energy Agency in Vienna carry out a study of the maximum permissible concentration of oceanic radioactivity. There is no notable contamination of the ocean as yet, but the increasing number of nuclear power plants make these preparations advisable, in the opinion of the committee.

Among other topics—and there were many—that aroused special interest at the Congress are the following:

The possibility of an increasing separation of the American continent from the European and African, at the rate of about one yard per thousand years, as a result of the continued bulging of the crust and a further uplift of the mid-Atlantic mountain ridge.

The probability that life did not originate in the sea itself but on the under-water clay surfaces in estuaries and shallow bays where "chemical evolution" took place for hundreds of millions of years at a time when the atmosphere was poor in oxygen but rich in hydrocarbons and perhaps ammonia. Increasingly complex organic molecules were formed by contact in concentrated layers absorbed in the clay until amino-acids resulted. These then combined to give proteins which were able to duplicate their own molecules. After that, organisation of the proteins into cells became possible and biological evolution could begin. The oxygen in today's atmosphere would prevent such chemical evolution, but the same process may well occur on the astronomical number of planets that may belong to stars other than our Sun.

The earliest fossils found anywhere show that evolution must already have been going on for long periods of time without leaving a trace. The explanation of this is that the earliest animals were plant-eaters with soft bodies; it was the much later appearance of carnivorous animals that forced the protective development of shells and skeletons which form fossils.

The discovery that the relatively rich life in the ocean near the Equator, where the upward currents bring nutrients, resulted in the formation of a continuous band of sediments round the Earth, which indicates that the Equator has been where it is now for some 500 million years. Consequently, the poles have not wandered about and some other explanation is needed for glacial periods.

The indication that the chemical composition of the sea has not changed for some 250 million years, that the

ocean has not become more salty and that therefore the salt in the ocean has not come from washing out the continents by rivers but must have some other, unknown, origin.

The discovery in the tropics of giant eel larvae, 6 in. long instead of a small fraction of an inch. This may mean that mature giant eels 100 ft. long may actually exist and account for the legend of "sea serpents". A large number of species, including "living fossils", may yet be discovered because the larger, swifter, or more intelligent specimens may escape present methods of bringing them to the surface. They may even be sensitive to the sound waves used by trawlers to locate shoals of fish and thus evade capture.

The level of the sea is now at least 300 ft. below where it was before the first glacial age some 400,000 years ago, perhaps because of the accumulation of ice on the Antarctic continent. But at the peak of the last Ice Age, about 10,000 years ago, the level of the sea was about 300 ft. below its present mark. Then a sudden warming and rise in the ocean level occurred and is still going on. If all the ice in the Antarctic should melt by continued warming, the level of the ocean would rise by at least 180 ft. and drown most present coastal plains. This could happen within the next 10,000 years.

In whales, seals, salmon, herring, and sardines, different blood types can be detected that distinguish various ethnic groups from others of the same species. They can be tested with rabbit serum just as human beings are. These data permit the identification of individual "populations", or schools, and could be used to follow their migrations and perhaps to explain their mysterious disappearance from fishing-grounds.

Sea plants and animals produce a wide variety of special chemical substances such as vitamins, antibiotics, growth stimulants, and hormones which may themselves be valuable to man and which, with further study, could explain the occasional explosive growth of some varieties and also the catastrophic death of millions of tons of fish, apparently by disease, at some times and places.

At the final banquet of the Congress, Dr Columbus O'D. Iselin of Harvard University reviewed the large number of unsolved problems that the Congress had revealed, and predicted that, with the upsurge of oceanic research which the Congress had stimulated, vast new food supplies would become available for the ever-growing human population of the earth. The present "hunting" of fish will be replaced by "farming" them when effective fences can be devised to retain them, when weed plants and animals can be eliminated in favour of valuable varieties, and when the growth of fish, both in size and in numbers can be stimulated by the effective fertilisation of sea-water, probably by bringing up nutrients from deep waters by control of the ocean currents. He also predicted control of weather and climate through an understanding and control of the ocean currents. The economic, social, and political problems raised by such developments will be a challenge to international law. The future of the oceans, he said, is of prime concern to the United Nations and its Agencies, properly symbolised by the fact that this first international oceanographic congress was also the first scientific meeting ever to be held in the headquarters of the United Nations.

THE VALLEY OF 10,000 SMOKES

Nearly half a century ago a large Alaskan valley was completely covered with the debris and hot ashes of one of history's greatest volcanic eruptions. All vestiges of life were consumed by fire though a trace of vegetation in a few sheltered spots may have survived.

The area, known as the Valley of Ten Thousand Smokes, now part of the Katmai National Monument in south-western Alaska, offered scientists an opportunity to observe first hand a telescoped re-enactment of the fundamental phenomenon of replacement of life on the planet.

A report of the biological surveys on the changes in the valley since the eruption has recently been written by Victor H. Cahalane, Assistant Director of the New York State Museum, and published by the Smithsonian Institution.

The first surveys, started about five years after the volcanic eruption, were carried on by a series of National Geographic Society expeditions. It was found that in this relatively brief period life had started to reassert itself amidst the smoking desolation. The explorers found patches of the quite primitive form of mosses known as liverworts. Up to about 20 years ago these liverworts and a few other quite primitive plant forms expanded luxuriantly as the ashes cooled.

For the next twenty years the progress was not followed by scientific observers. Then six years ago Mr Cahalane and his associates resumed where the former expeditions had concluded their work. One of the important objectives of the survey was to gather data on useful or poisonous plants, dangerous animals, and other information that might serve military needs from the survival aspect.

They found that the ancient mosses had almost completely disappeared. It was presumed that the gradual cooling of the soil had produced a condition unfavourable to their survival. But higher plants, including some flowering species, have gained a precarious foothold. Altogether thirty-five species were collected, including several grasses, dwarf willows, and the lovely Arctic poppy and dwarf fireweed. Most of these are apparently holding their own. From year to year conditions will presumably become more favourable for them.

In most cases, it is likely, seeds were blown in from outside the area. The investigators, however, found several "plant islands". These are in areas that were probably slightly protected from the fall of hot ashes and may be survivals of the original vegetation of the region, about which nothing is known.

From now on the revegetation of the valley will be followed from year to year. Plots, each with its own limited plant growth, have been staked out and will afford bases for observing the development under the varying conditions which now obtain.

The animal life present before the eruptions was unable to survive, but since then the area has been increasingly re-invaded by the same species from near-by areas. In due time it may be expected to show once more a faunal picture more or less like the original one. So far as human beings were concerned there could have been at the most only a few scattered Eskimo villages farther away, the inhabitants of which had sufficient warning of the coming catastrophe so that they were able to escape.

REDUCING JET NOISE

The onset of the commercial "jet age" has made the public more noise-conscious than ever, partly because so much was written about the "intolerable" and "unbearable" noise levels likely to be the order when the jet airliners started operating. While the new Comets and the Boeing 707 Stratoliners have not proved excessively noisy, big jets such as these can be very noisy machines unless something is done about quietening them.

Practical steps towards reducing jet noise to minimise the nuisance factor began some six or seven years ago when a growing number of complaints were made by residents in the areas of military aerodromes. The fighters and bombers that had been designed to answer the needs created by the Korean War were making their presence known at aerodromes round the country. As the trend was towards more power—meaning more noise—something had to be done, because excessive noise is not only audibly unpleasant but physically injurious.

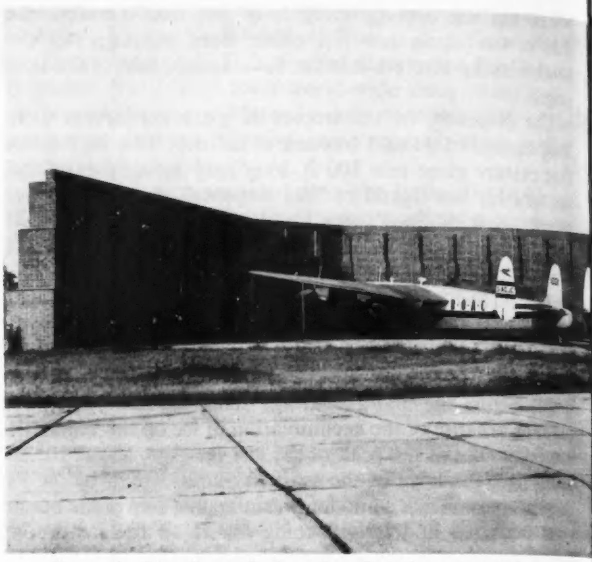
An obvious move was to look at the matter to see just what created jet noise and determine the levels at which it became unpleasant. The last was the greater problem, for people have different views on what constitutes a noise-nuisance—the city worker compared with the country worker, for example, may have less cause to complain about his peace being disturbed by the noise of traffic.

Jet noise, or the noise created by a turbo-jet engine, is caused mainly by the shearing action between the issuing jet and the ambient air, and the subsonic noise is at its worst when the aircraft is stationary or climbing. A deeper, "choked" noise associated with re-heat and rockets is due to a powerful resonance through the nozzle and emanates from shock waves occupying the efflux. Noise from the mechanical process of burning inside the engine does not contribute very much at all with jets; with propeller-driven aeroplanes it is mostly mechanical noise, like propeller-tip vibration, that makes things less than pleasant for the traveller.

There were two main ways open to technicians to reduce the sound of jet engines: tackling the problem at the source, that is in the engine itself, and by employing muffling devices and silencers that could quieten the engines from outside. Intensive studies have been made in Britain and the United States to find which method could be most successful.

Originally the problem was one more for the military authorities than civilian, and it was decided that military jet aircraft running-up should be quietened on their base. As experiments had shown that there was not much hope of reducing jet noise substantially at the source, "running-up pens" and jet mufflers of sizeable proportions were introduced at military airfields and aircraft establishments round Britain. At Dunsfold, Hawker Aircraft Ltd erected running pens to reduce the noise of Hunter fighters under test, and at South Marston, Wilts., Vickers-Armstrongs built a special pen to test the installed engines of Swift fighters. In the United States, Republic Aviation employed rows of special mufflers for individual aircraft.

For the most part, these noise-reducers worked in the same way: the aircraft was wheeled to the device and its jet orifice was pushed into an open nozzle on the installation. By mixing the sound waves as they roared from the jet, and breaking down the notes from an ear-rending high to a more tolerable level as they flowed through the quietening device, much of the noise was dissipated. Early installations served to absorb noise, though in rather a crude fashion. These efforts were not without cost, for apart from involving large sums of money, the physical danger was strongly felt with the death of at least one man (Mr Quentin Reeves) who was killed by the silencing gear he had helped devise.

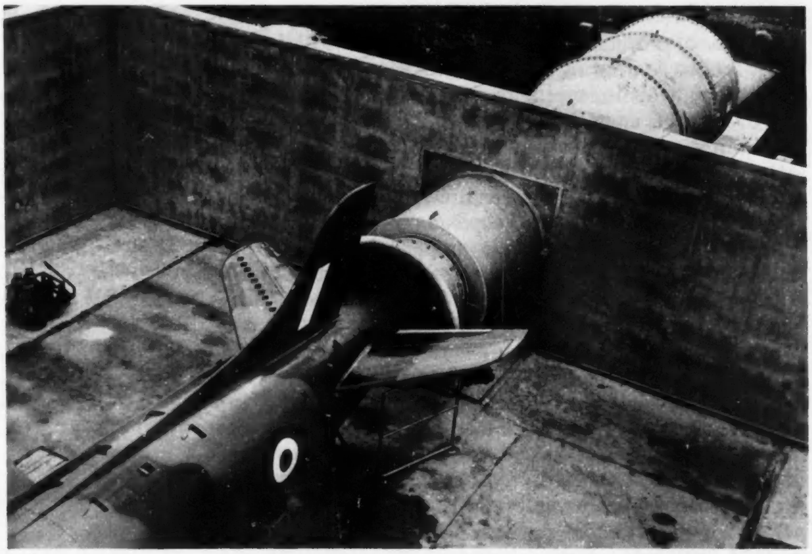


An early idea for reducing aircraft noise was tried at London Airport in 1953. A BOAC aircraft undergoing normal performance test behind a specially constructed acoustic screen wall, the first of its kind to be built in this country.

With the development of civil jet airliners the problem was brought home to operators and airport authorities, and concerns such as the Boeing Airplane Company had the task of ensuring that their airliners conformed with standards laid down by such bodies as the Port of New York Authority. The PNYA maintained, rightly, that there was a limit to airliner noise and that this limit had been reached. It was up to Boeing—and other companies—to see that their aircraft were quietened if commercial jet services were to start.

Boeing, Douglas Aircraft, de Havillands, and the engine manufacturers, Pratt & Whitney, Rolls-Royce, and so on, invested millions in man-hours and money to develop silencing devices that could be fitted to the aircraft, for clearly airport terminal operations prohibited the use of ground devices; moreover, these could not provide the answer for take-off over the communities for which the regulations had been drawn up.

The results we saw when the jets entered service. The Boeing noise-reducer, or ameliorator (which involved $10 million) appeared in final form as a 21-tube device, which not only suppressed much of the noise of the Pratt & Whitney engine to which it was affixed but changed the sound characteristics. The Rolls-Royce device on the Comet, largely the work of Mr F. B. Greatrex, who, under an inter-company agreement, shared his knowledge with Boeing, emerged as a simpler-looking corrugated nozzle



The new jet "Muffler" at Vickers-Armstrongs Supermarine factory, S. Marston.
(By courtesy of Vickers-Armstrongs)

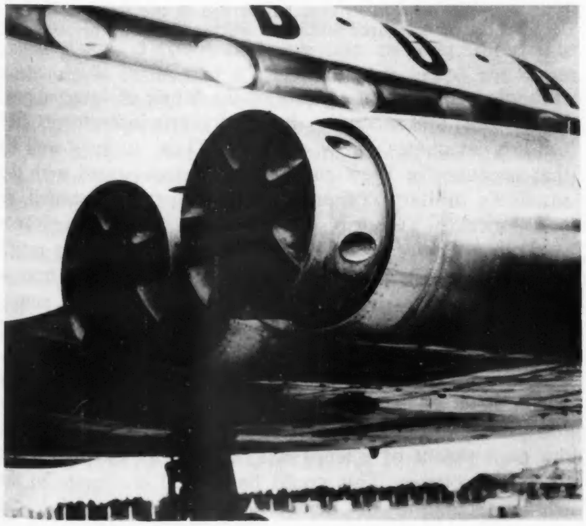
attachment capable of providing a noise reduction of at least 6 decibels (dB). Both devices have been effective enough to prevent complaints at the airports.

What next can be expected? At this stage it seems unlikely that further development of existing types of suppressors would yield much more in the way of noise reduction. Thousands of different nozzle shapes have been tried, and the most successful devices are being applied. The decibel (the unit by which noise is most often measured) is a difficult thing to design for, and future work towards noise reduction might be directed along different lines; the development of by-pass and turbo-fan type engines, for example, which are attractive to civil operators primarily because of their more economic and efficient running and yet which are inherently quieter engines.

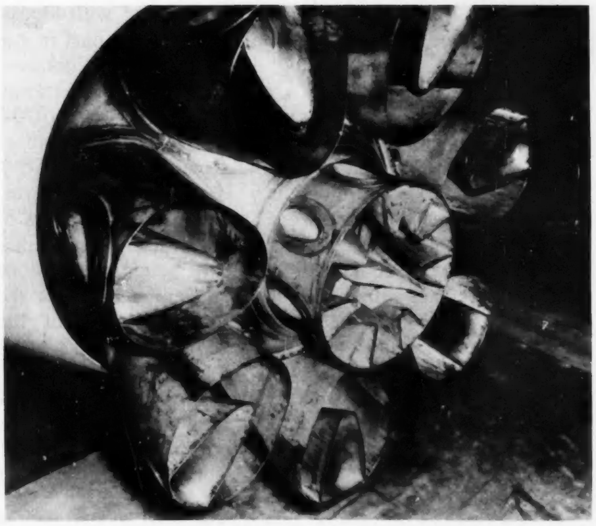
It can be expected, anyway, that research into noise reduction will continue, for much remains to be done. If the turbo-jet airliners of the 1960s are no noisier than at present there will be very many more of these airliners operating, which means the noise nuisance around airports can be expected to be greater. Other machines such as helicopters will have to be quietened also; we can look forward to seeing these in increasing numbers, together with the convertiplane type like the Fairey Rotodyne. Particularly apposite here is a comment made recently by Lord Douglas of BEA when indicating the intention to buy up to twenty Rotodynes: "Among the problems [which must be met] the most important includes silencing the aircraft sufficiently for it to fly into city centres. . . ."

In concluding this brief note, it must be hoped that the aeronautical future is not much noisier, if not much quieter, than the present.

Two of the four Rolls-Royce RA-29 Avon engines of the Comet 4 prototype fitted with Rolls-Royce suppressors.
(By courtesy of de Havilland)



A close-up of the silencing nozzles manufactured by Douglas Aircraft to Rolls-Royce designs and fitted to the Douglas DC-8 jet airliner.
(By courtesy of Rolls-Royce Ltd.)



SCIENCE AND DIPLOMACY

A quarter of a century ago it would have been sacrilegious for a serious journal to publish an article on this subject. Even today, when science is recognised as an essential tool of government, and when the scientific spirit is beginning to permeate our whole way of life, the gulf between the scientific community and the practitioners of foreign policy remains extremely wide. There are many reasons—some of them complex—for this. The vision of diplomacy as an élite profession dies hard: the concept of diplomacy as an activity to be carried on in secret, while science needs a full interchange of ideas, leads us inexorably to a potentially undemocratic position which that scientific and humanistic observer of foreign affairs, Mr George Kennan, so rightly fears. "I am reluctant", he writes, "to cross that crucial border beyond which one admits that foreign affairs are exclusively the province of the full-time professional, in which the views of the private citizen can have no value." It is significant, too, that Lord Strang, a former Permanent Under-Secretary, in his authoritative work, "The Foreign Office", recognises that through the technological revolution of our time, relations between the nations are constantly growing more complex, and that there are a whole range of problems relating not merely to the necessary improvement in communications, but more crucially to the ability of the men at the top, "who are not supermen", to cope with problems which threaten to be beyond the limitations of a single brain. In effect, the relations of science and diplomacy must be viewed on three separate, if interrelated, levels. First, there is the important, if narrow, issue of the application of science within the existing techniques of foreign affairs. Second, there is the enlisting of science as a methodology to focus more effectively the priorities and objectives of foreign policy. Third, there are the relations between states, which lie at the root of foreign policy, in the light of a scientific understanding of man, society, and environment.

Space permits only a cursory examination of the role of science in Britain's overseas relations. Outside the position of science in our defence programme,* and our contribution to the various specialist agencies of the UN, notably UNESCO, WHO, FAO, and those associated with atomic energy, science plays an important but limited part in our foreign affairs. We would highlight the British Commonwealth Scientific Offices as a clearing-house of Commonwealth scientific collaboration, and the work, both of the Overseas Liaison Division of the DSIR and the Standing Committee on Overseas Scientific Relations of the Advisory Council on Scientific Policy. It would appear, nevertheless, that these channels deal primarily with matters of scientific liaison, and that so far as the overseas representation of science is concerned, two U.K. scientific missions and three science attachés is surely a slender basis for the present age. While the traditionalist character of the British Foreign Office may partly explain Britain's weak position in this field, recent U.S. experience suggests that we are concerned here with an even more basic defect of Western democratic outlook. As long ago as 1950, the Department of State, in collaboration with the U.S. National Academy of Sciences, produced a report entitled "Science and Foreign Relations", advocating both the appointment of a science adviser to the Secretary of State, and the appointment of scientific attachés abroad. So slowly had the implementation of this report progressed prior to the launching of the *Sputnik*, that in 1957 the U.S. had 500 military attachés assigned to its foreign missions, and not one single scientific attaché! While belated steps have been taken to remedy this, can we be surprised that policy-makers of the West have had little appreciation of the international reaction that was to follow the accomplishment of Russia's scientific feats? Basically, two propositions merit greater recognition: first, that science and technology are essential facts of the fabric of international intercourse; and secondly, that diplomatic instruments, like military machines, grow obsolete. Thus, it may well be that because the West has been too preoccupied with the satellite's military consequences that we have tended, as one American authority puts it, to miss "[its] significance . . . as a Soviet bid to gain power by capturing man's imagination". Perhaps the cold war is changing from a military struggle, even from an economic struggle, into a competition for intellectual pre-eminence between two types of society. While this could be a healthy development, it does pose special problems for the West. Recent studies which have projected exponentially the doubling of our scientific effort every ten or fifteen years suggest that the deployment of science will impose increasing strains on our resources. This could be a vital challenge to the whole technique of democratic government, for can

Dr Thomas H. Osgood, a physicist with a combination of research and administrative experience, is the new Science Officer at the American Embassy in London. Dr Osgood, who was born in Britain, has served as the Dean of the School of Advanced Studies at Michigan State University since 1950.

* See DISCOVERY, 1959, vol. 20, No. 6, p. 229.

there be that necessary planned and purposive growth of science without damaging the flexibility and individual freedom which we believe to be the centre of its creative being?

There is, perhaps, an even vaster concept to be realised by the foreign policy-makers which gives added force to our continuous emphasis on science as not merely a tool but an "emotion" pervading our whole intellectual approach. Foreign policy can no longer settle the individual affairs of nation-states *in vacuo*. Moreover, we have been too preoccupied with science and technology as an aid to bettering material conditions, and we have paid insufficient attention to the factors controlling human behaviour. Sir James Gray, in his celebrated presidential address to the 121st Meeting of the British Association, recalled that "the animal throws the dice but the environment calls the winning numbers". The same is true of man as a political animal, and especially of the behaviour of separate nation-states. If each nation strikes out exclusively for itself, if countries allow their populations to grow unchecked while enlisting the help of science in winning the highest possible living-standards for their own people, it will, in the long run, be the environment and not man which triumphs. If the evidence of the natural sciences has any relevance, it is that the urgent task of foreign policy in a scientific age is, both by example and by persuasion, to speed the transition of the mainsprings of policy "from natural traditions and aspirations to others based on international welfare".

NEW MINIATURE CAMERA

A revolutionary miniature camera fitted with a 180-degree ultra-wide-angle lens has been developed by the Australian Department of Supply's Weapons Research Establishment in South Australia. Used in missiles research, the camera records target interception and provides scientists with quick and accurate information about a missile's performance at Woomera Rocket Range.

The tiny camera is only $1\frac{1}{2}$ in. wide and $1\frac{1}{4}$ in. long and weighs 8 oz. The lens enables all-round coverage to be obtained with the use of only two cameras. The new camera is fitted with an explosive-operated shutter, and exposure is completed in less than 1/1000th of a second from the initial signal. Two of the miniature cameras, fitted into each missile instead of a warhead, photograph the target at the instant when the warhead would be fired. From the photographs scientists are able to assess the effectiveness of the missile. The cameras are robust enough to be recovered from the missile after it falls to the ground at the end of a flight and can be used again.

Initial development was undertaken by Weapons Research Establishment scientists and the manufacturing development was carried out by the Fairey Aviation Co. Pty. Ltd. The company's general manager, Col. R. T. Elvish, said that the lens was intended for use in high-speed photography. A plane using the lens in a movie-camera could photograph a whole city the size of Canberra from a height of about 1500 ft.

HIGH HOPES AT OLYMPIA

The National Union of Teachers' Education and Careers Exhibition held at Olympia in May gave an exciting idea of what it would be like were the 1944 Education Act ever to be implemented. In bright classrooms of manageable size, the children were guided by sympathetic and imaginative teachers, using modern techniques, to an understanding of the world they live in and will work in. The school was presented as the process through which the children are formed into the efficient and informed wage-earners of the future, rather than merely a place for biding time until going into the world as adults. The children made dyes, spun yarns, and wove textiles themselves. They made colourful tapestries and clay models of cities they had read about in history classes. The emphasis everywhere was on learning through imagination and doing.

The fact is, however, that only a few of the state schools are so fortunate, for in the fifteen years since the nation's educational objectives were set down in the Education Act, many of its main provisions have gone unfulfilled. The school-leaving age is still too low, as has been emphasised by the recent Crowther Report. One-third of all primary-school children attend classes of more than forty pupils, and in secondary schools one-half attend classes of more than thirty. There are neither enough teachers nor enough schools, and the shortage of teachers is particularly acute in science and technical subjects. Some of the most beautiful of modern buildings now going up are school buildings, yet half a million children attend schools built before 1870. Many schools are housed in slum buildings lacking outdoor space; sufficient books and material for classroom study; enough fittings and furniture for general school use; and apparatus for laboratories, workshops, and gymnasiums.

In 1938 the yearly expenditure on education in England and Wales was about 3% of the total national income. Twenty years later the percentage was still the same. The same fraction was being stretched to cover the educational needs of nearly $2\frac{1}{2}$ million more children. Putting money into education is one of the best investments a nation can make, for it will mean more skilled workers and a higher standard of living. It is true that a more skilled labourer will want a higher wage, but higher wages mean more consumer power and an increased demand for technical goods. This, in turn, means more profit and a greater incentive to research and expansion.

At the exhibition a demonstrator who was reluctant to explain his exhibit to the children was heard to remark: "After all, they're only secondary moderns." But those who dismiss the products of these schools as unteachable are writing off three-quarters of each generation. All employers want intelligent and efficient workers as well as able men in top positions. In spite of this, many disregard the Education Act's day-release scheme which allows young workers to take "sandwich courses" to further their training in their chosen fields. One often hears complaints about the poor quality of today's generation: no sense of responsibility, unreliable, poor judgment. But do the complainers exercise their right as voters and ratepayers to demand improvement of the schools where more desirable personal characteristics should be formed? In a nation where it is now taken for granted that good health is a right and not a privilege, a good education is still covertly regarded as a very expensive privilege.

SNOW LOADS AND ROOF DESIGNS

In Canada, the heaviest load for which the roof of a building must normally be designed is the load imposed by snow. The magnitude of the design snow load is therefore of considerable importance. It must be high enough to reduce the probability of failure to an acceptable level, but at the same time not so high as to result in unreasonable construction costs.

Snow loads to be expected in different locations across Canada are given in the National Building Code. These loads are based directly on measurements of maximum ground snow depths over a number of years and are generally considered to meet the requirements of safety. Indeed, it has been said that they are excessively safe and that in some cases they result in unnecessary costs. It has been claimed that measurements of ground snow depths are not directly applicable to the determination of roof snow loads because superficial observations had shown that roof snow depths were usually appreciably less than ground snow depths.

Recognising these criticisms and appreciating the influence of design snow loads on the cost of construction, the National Research Council Division of Building Research, decided to undertake a study of the actual accumulations of snow, ice, and rain on roofs as well as on the adjacent ground. It was realised that this study must be carried out for a number of years and take into account the whole of Canada. Before embarking on this project, a pilot survey was conducted during the 1956–7 winter. Its results showed that a country-wide survey of actual snow loads on roofs would yield useful information and that the proposed method and apparatus used would, with a few changes, be suitable for the full survey.

During the next winter, 1957–8, the first set of full survey observations was made. More than fifty observers across Canada measured the depth of snow on many different roofs and on the ground surrounding these roofs. Some also measured the density of the snow. Depending on the types of observations made and the types of roofs observed, these observers were divided into three groups. Those who measured snow depth and density on one flat and one pitched roof of residential size and on the surrounding ground were called A-Station observers. At these stations snow depths on the roofs were measured by means of mounted gauge sticks and on the ground with a yardstick. The density was determined by melting a known volume of snow and calculating the weight of the melt water.

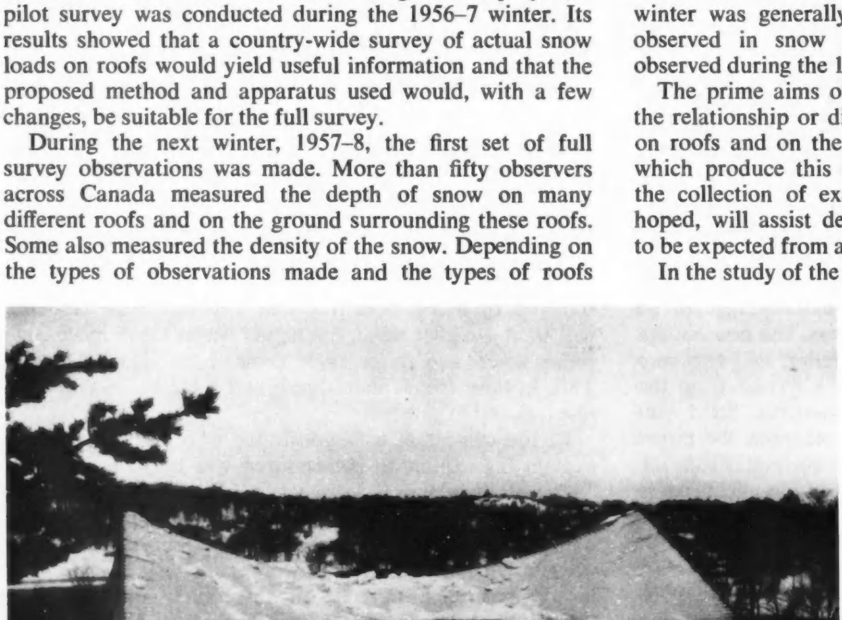
B-Station observers, who are usually building inspectors and other interested persons, made less detailed observations on one roof of residential size, either flat or pitched, and on the surrounding ground. Unlike A-Station observers, they measured only the depth of the snow. This was usually done with a yardstick. Additional depth measurements were made on other roofs at the time when the snow loads were at a maximum for the winter.

C-Station observers made the equivalent of A-Station observations on very large roofs located at RCAF bases across Canada. They measured the depth and density of the snow on the roof of large hangars and other buildings and on the surrounding ground. All depths were measured with a yardstick and the densities were determined as at the A-Stations. At C-Stations, as at other stations, measurements were usually made weekly and after every heavy snowstorm.

The full survey organised in this way has already produced useful results. Although the snowfall of the 1957–8 winter was generally below normal, certain trends were observed in snow accumulations. Similar trends were observed during the 1958–9 survey.

The prime aims of the survey are the determination of the relationship or difference between snow accumulations on roofs and on the ground and the study of the factors which produce this difference. Another important aim is the collection of examples or case-histories which, it is hoped, will assist designers in determining the snow load to be expected from a given set of conditions.

In the study of the factors that affect snow accumulations



The investigation of roof failures due to snow loads was an important part of the survey of the 1958–9 winter. The roof of this house failed under a load of approximately 40 lb./sq. ft.

on roofs, information in addition to that supplied by the observations is used. Detailed information on the roofs under study with a description of neighbouring structures and surrounding topography is obtained. Records of wind, temperature, sunshine, and snowfall from the Meteorological Service of the Department of Transport supplement the records.

Although no definite conclusions can be drawn from the observations of only two winters, a number of trends in snow accumulation on roofs have become evident. In general, the average snow loads observed on roofs were found to be appreciably less than the corresponding ground loads. This difference was quite variable and primarily dependent on the degree to which the roof is sheltered from the wind by surrounding trees and buildings. Observations also indicated that secondary factors in creating the difference between roof and ground snow loads include heat loss from the building through the roof and solar radiation.

On many roofs where the average load was less than the corresponding ground load, concentrations of snow greater than the ground load were frequently observed. Split-level roofs, for example, were observed to accumulate concentrations at the junction of the levels. Entrance canopies and lean-to roofs were also observed to accumulate heavy concentrations. These concentrations appeared to be created primarily by the shape, size, and orientation of the roof.

In addition to the observation of roof and ground snow loads, the survey also includes the investigation, when possible, of roof failures caused by snow loads. Many opportunities for such investigations occurred during the 1958–9 winter, when many roofs collapsed, serving as a reminder of the danger that can be created by heavy snow loads on roofs.

With the observation of the 1959–60 winter, the full survey is now in its third year. After several more winters of full survey observations it is expected that the information obtained will provide the basis for more rational design snow loads in future editions of the National Building Code —snow loads that will be safe but economical.

THE PHILOSOPHY OF "CAN'T"

One of the greatest gifts of childhood is an open mind. The purpose of an education is to make this faculty selective so that in the realm of ideas it can winnow the wheat from the chaff. Experience, it is said, contributes to the evaluation of these ideas so that in a given situation the idea most applicable can be selected.

Unfortunately, more often than not, these principles do not obtain. Unwittingly, education provides the knowledge with which to reject ideas, and experience, the authority to kill them outright. This pattern of behaviour varies, being least evident in societies which are building for the future, like the U.S.A. and the U.S.S.R., and most evident where there is a heritage of past greatness to preserve. In fields where the future is unlimited, like science and technology, an open mind—a mind which dares to admit the possibility of the impossible—is even encouraged. But science and technology have been going through a revolution for the past fifty years and have become accustomed to accepting new ideas and discarding old concepts. Hence we have an American astronautics firm which uses the slogan: "The Heavens are not too high."

In the more orthodox fields of human endeavour, such brashness would be considered intolerable. Of course, now anyone will admit that the heavens are within our grasp, but then hindsight does not require courage. Ten years ago the serious advocacy of such a goal would have placed one in the lunatic fringe. Today there are the courageous few who challenge the universality of gravity. And everywhere there is the educated, experienced Greek chorus saying: "It can't be done." Time alone will tell, but it is encouraging to know there is a handful of bold, unfettered minds which refuse to accept the doctrine of "can't".

It is in the field of more prosaic things that the "can't" doctrine is strangling progress. Recently, in a letter to an editor, it was used to strangle the solution of the traffic problem. We can't reduce the tax on cars, the argument went, because that would lead to more cars which would clog the roads, and we can't improve the roads and build motorways because we can't get the money or the land. Equally tragic are the 99 "can'ts" threatening the future of the aviation industry, opposed figuratively to one "can".

Examples of the "can't" doctrine could be cited *ad infinitum*, but these two instances will suffice. At the root of the trouble is the fact that human nature is lazy, and the easiest way out is to condemn a new idea with some moth-eaten principles which, more often than not, are not applicable. But there is a basic principle which works. It is so ancient it has become a platitude and, like all platitudes, it is ignored. It is expressed by: "Where there's a will there's a way."

But the will to change the *status quo*, to seek better ways of doing things, to apply the searching light of new concepts to established thought patterns is resented. Until recently, to suggest that life could be better in England by using central heating branded one as weak, soft, and anti-British. It is still not a popular conversation topic because those who do not use it are on the defensive and the arguments they use to preserve a way of life which would have been intolerable to the Romans are devoid of all reason.

But the world will not stand still. There is much more to be done. In the older fields of endeavour, as, for example, the railways, the challenge is great. (What is the reason why bright young men do not seek to go in this field? Is the doctrine of the *status quo* too strong?) We must keep re-examining our institutions and systems to see if they meet today's needs. Is it in the public interest that a boy who steals a bicycle-pump is charged with an indictable crime while a dangerous driver is not? Is our educational system steering the curiosity and rebelliousness of our students into productive outlets, or is it producing more and more "think alikes". The nonconformist, the rebel with a cause, is difficult to absorb into an established system. But our educational system must recognise and encourage these individualists, and our institutions must use them and reward them. It is they who see the truth, the truth which sounds like heresy:

Authority is transient, laws are mutable, facts are temporary.

By keeping us reluctantly aware of this fundamental law they make whatever progress we achieve possible.

THE DEEP HOLE

GORDON G. LILL

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We know more about the interior of the Sun than the interior of the Earth. Plans are advancing fast for drilling a hole into the Earth's mantle from a platform moored in deep ocean.

Since the classical times of Ancient Greece, inquisitive people have constantly speculated upon the nature of the Earth's interior. The speculation which survived over the longest time grew out of the teachings of Aristotle which pictured the centre of the Earth as a great fire with whirlpools of water descending through large holes in the ocean floor, only to be heated and belched forth again as steam from volcanoes. This idea was given credence by some until well after the Dark Ages, and it crops up even today in the unpublished works of our voluminous eccentric literature.

Others throughout history have believed the centre of the Earth to be solid, frozen, or molten depending upon the viewpoint of the leaders of science at the time. Today most of the ancient concepts of the Earth seem odd to us. However, even today we are not free from speculation about the Earth's interior although our thoughts may be based on some physical evidence.

The idea of sampling the mantle was first proposed by Dr Frank Estabrook a few years ago. Later, not knowing of Estabrook's proposal, Prof. Harry Hess of Princeton University, and Prof. Walter Munk of the University of California jointly developed the same idea. These scientists believe that the Earth sciences require a large and exciting project in order to compete with similar projects in other fields and thus to maintain a proper balance and perspective during the present period of rapid scientific development.

The drilling project was entrusted to the American Miscellaneous Society, or AMSOC, which became instrumental in the establishment of the AMSOC Committee of the National Academy of Sciences-National Research Council. This Committee, of which the author has the honour to be the chairman, is now gathering information on which to base the work. It has been decided that it would be feasible to drill from a barge over the deep ocean to about 30,000 ft. below sea-level. It remains for the drilling site to be chosen, the funds to be secured, the hole to be drilled and arrangements made for the analysis and publication of the results. A panel of the committee is working on the site selection now.

THE EARTH'S STRUCTURE

In considering the reasons for drilling the hole we should first examine the knowledge we have of the Earth's interior. In Fig. 1, for instance, we find compiled most of the physical information available. All the data presented here was obtained indirectly even though based on acceptable scientific procedures. The Earth's structure shown in this diagram was obtained by studying the travel times of earthquake shock waves from their points of origin to points of observation. The temperature, density, and pressure were obtained from laboratory and theoretical studies backed up by some field measurements when possible. The laboratory and theoretical observations agree quite well with the seismic measurements made in the field, so there has been developed a rather pleasing and orderly concept of what the Earth must be like at great depths. However, the measurements are indirect, and it has been frustrating to some that we have never been able to explore inside the Earth much as we do outside it—into the atmosphere and beyond.

In investigating that portion of the Earth which is most accessible to us, the crust, we have discovered that under the ocean basins the crust is thinner than it is under the continents. This information has also been obtained by an indirect method which is illustrated in Fig. 2. Through analysis of the sound waves, which are picked up by the listening ship, marine geophysicists have worked out the depth to the Earth's mantle under the oceans, and the thickness of the various rock strata above the mantle.

During the last twelve years marine geophysicists have discovered some very surprising things about the Earth's crust under the ocean basins which have raised many troublesome questions. In Fig. 3, the reader will note, there are three layers of material under the ocean basins which have differing characteristics. Worthy of special attention is the fact that there is no granite under the oceans as there is under the continents, and the crust under the ocean is correspondingly thinner.

Another problem is why do we find but an average of 1000 ft. of sediments in the oceans? (See Fig. 3.) If the deep ocean basins have always been one of the gross features of the Earth's surface, then at the observed sedimentation rates we should find the sediments to be many times thicker than they actually are. The question is, what happened to the ancient sediments? Everywhere in the oceans we find that the oldest are only about 100 million years old, whereas there should be fossiliferous sediments nearly five times this old. We are undecided about the nature of the second layer which is shown in this diagram, but there is some possibility that it is a layer of volcanic material which was spewed out upon the ocean floor covering over the sediments which were already deposited there. In that case we would find that parts of the second and third layers are sedimentary in nature. If this is so, we would then be provided with a wonderful history of the Earth, since we could study the fossils found there and date the various layers. The second layer is also critical for another reason, for if it turns out to be a layer of limestone instead of some other material, then we will have to re-examine our notions about the world geochemical balance because we already have all the limestone of the world accounted for in our geochemical analyses.

At the point which is labelled "Moho Discontinuity" (officially known as the Mohorovicic Discontinuity) we find that sound velocities increase markedly. This change in

*This paper was presented in the main before a symposium, entitled "The Undiscovered Earth", sponsored by the Southern Research Institute in Birmingham, Alabama, June 1959.

THE STRUCTURE OF THE EARTH

FIG. 1 (*right*). Present-day assumptions of temperature, density, and pressure within the Earth are largely based on laboratory experiments, although the densities have been related to certain types of rocks such as peridotite, serpentine, and eclogite.

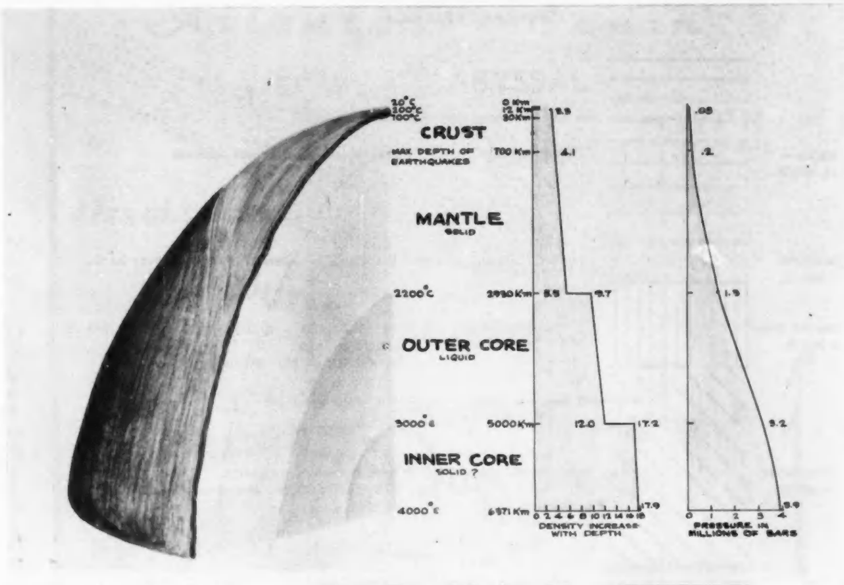
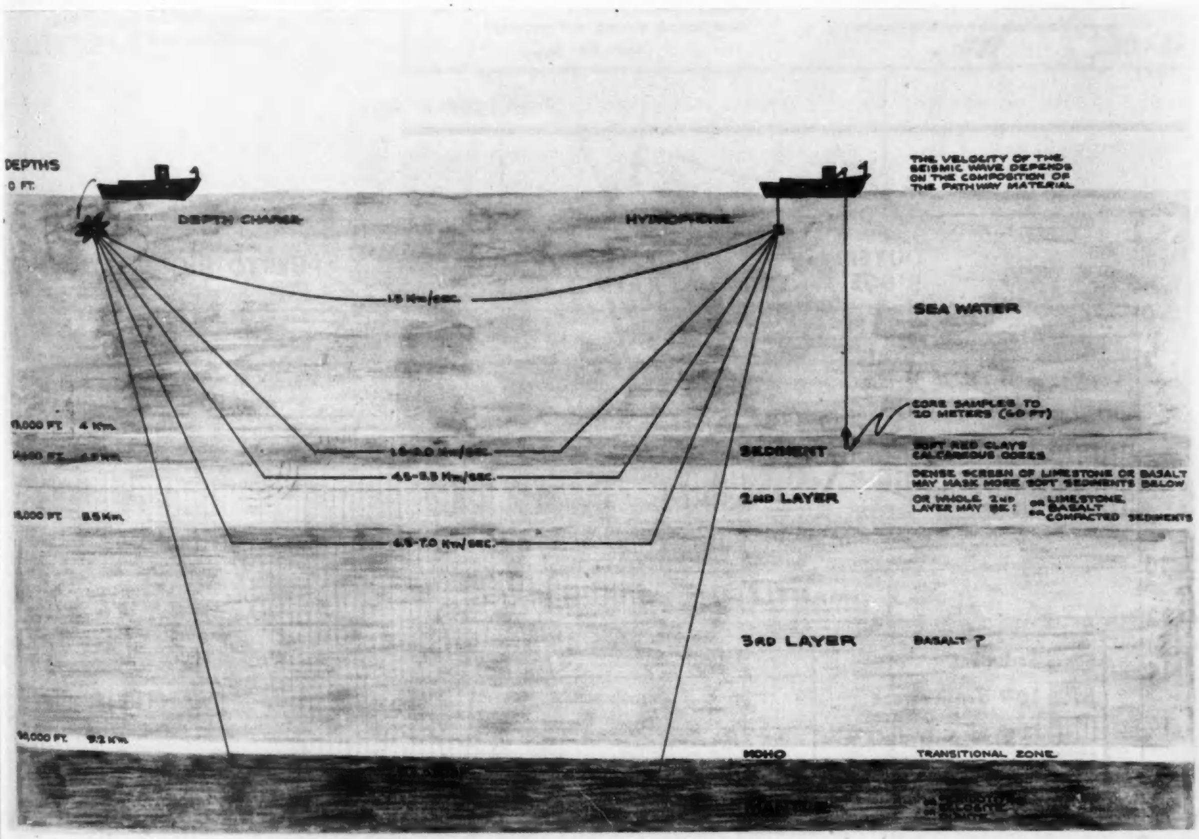


FIG. 2 (*below*). A diagram of one method of performing geophysical research at sea. For detailed shooting as many as four ships are sometimes used in a line.

SEISMIC REFRACTION SURVEYING

SHOWING PRINCIPAL PATHWAYS OF THE SEISMIC WAVES



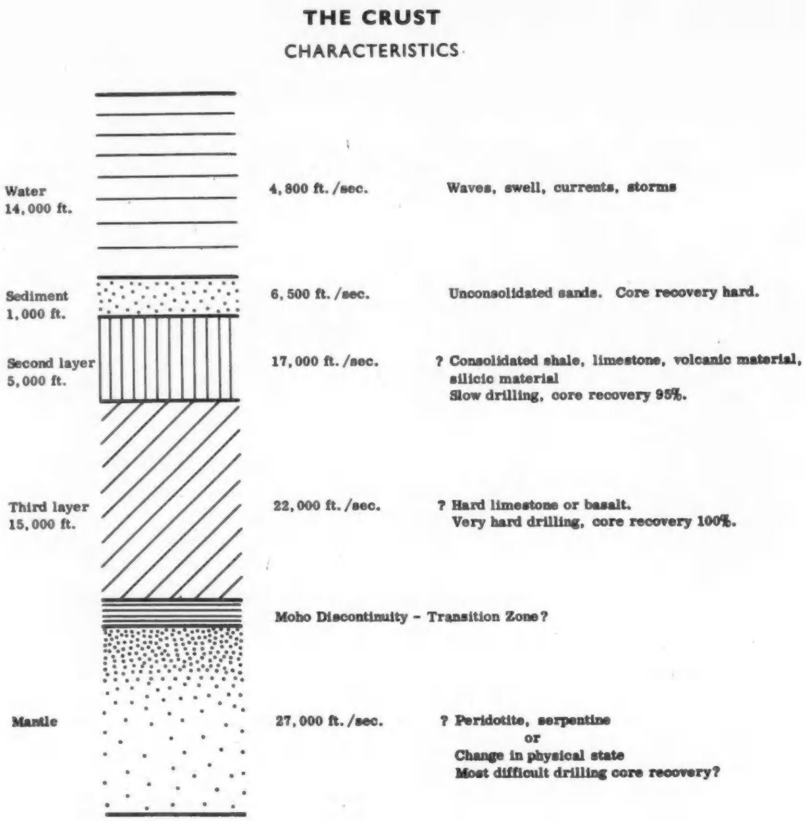


FIG. 3 (*left*). Under the oceans the Earth's crust is quite often found as shown here. This diagram is based on discussions held at the Scripps Institution of Oceanography during an informal seminar on the deep drilling project.

FIG. 5 (*below*). Scientists at The Lamont Geological Observatory present this estimate of the Earth's structure around Puerto Rico.

(Reproduced by kind permission of Dr W. Maurice Ewing)

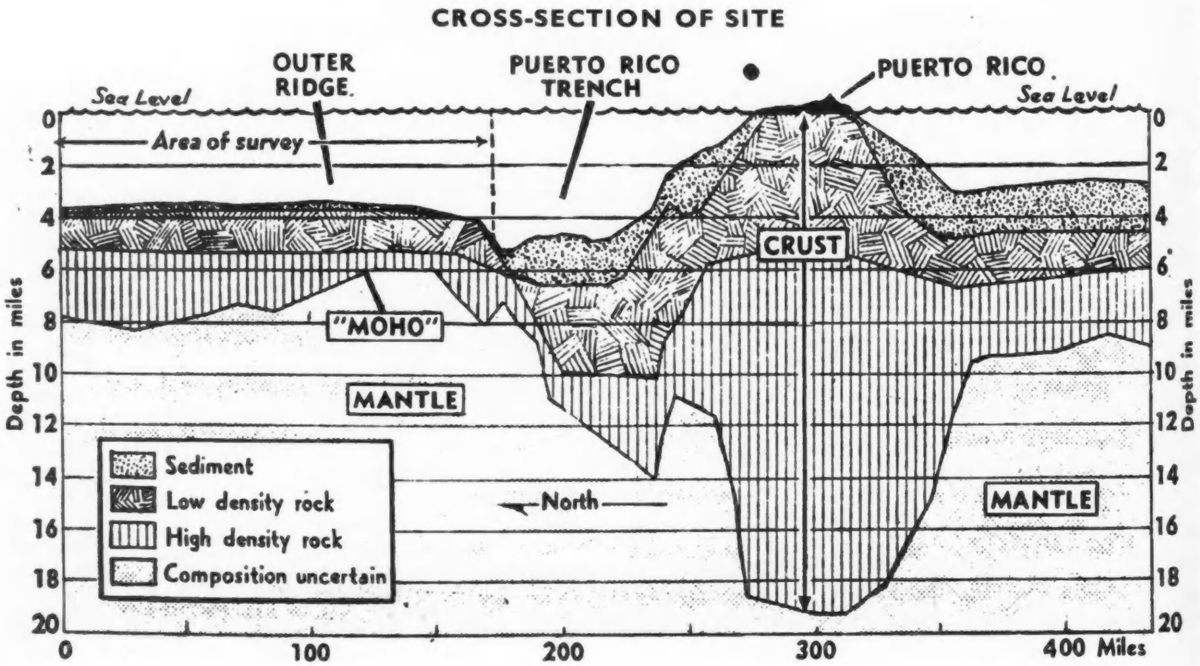
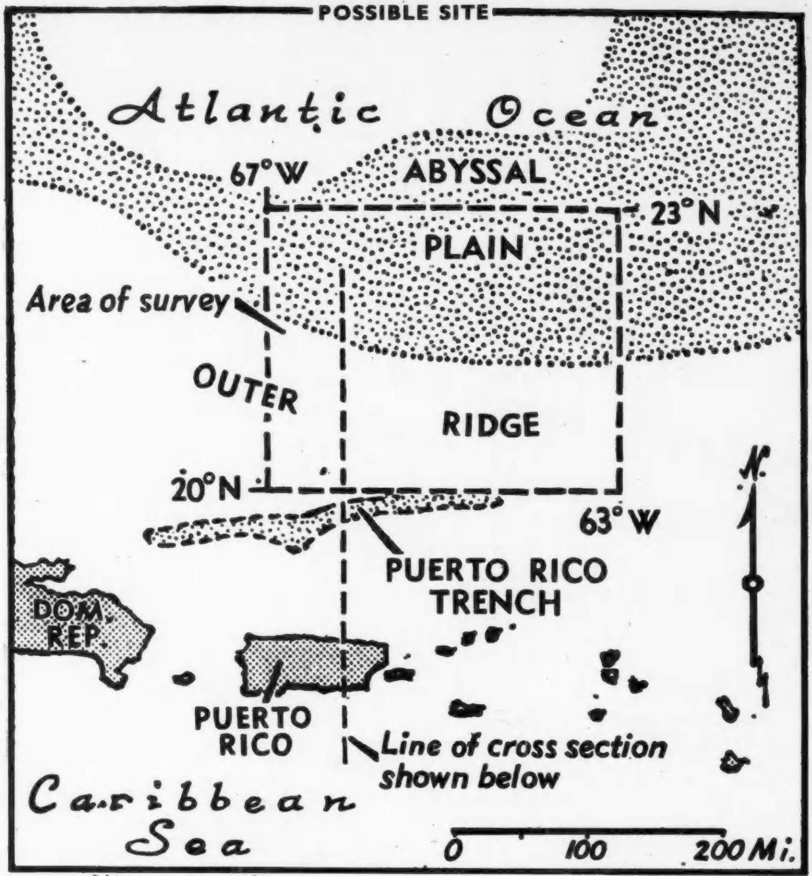
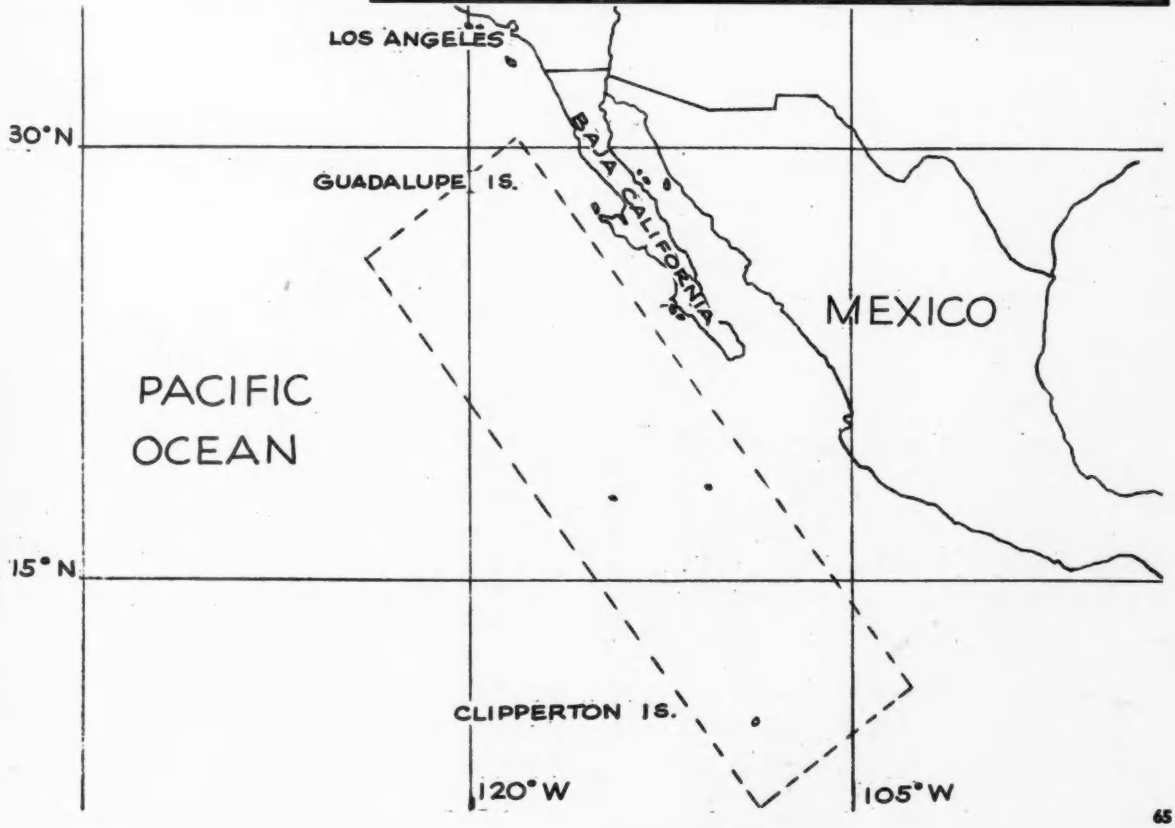


FIG. 4 (*right*). This area was recently surveyed by four ships under the scientific direction of Dr Jack Nafe on board *Vema* from the Lamont Geological Observatory. Other ships participating were U.S.N.S. *Josiah Willard Gibbs* from Hudson Laboratory, Columbia University; *Bear* from The Woods Hole Oceanographic Institution, and *Hidalgo* from The Department of Oceanography and Meteorology, Texas A. and M. College. Results from this survey are being analysed.

FIG. 6 (*below*). Under the direction of Dr Russ Raitt and Dr George Shor at The Scripps Institution of Oceanography, the area shown here is being surveyed as a possible drilling site. Preliminary results show that this area is just as good as the one north of Puerto Rico. Plans are to drill sedimentary sections, at least, to the southwest of Guadalupe Island in order to gain necessary engineering, oceanographic, and structural information.





velocity has long puzzled seismologists, for it has several possible causes. One possibility is that the rocks below the discontinuity gradually change their physical state due to the great pressure and high temperature, or it may be that the dense basic rocks, peridotite or serpentine, exist there and that the change is an abrupt one. Perhaps the discontinuity represents the early primitive surface of the Earth, so that the material in the Moho may give us some clues to the Earth's origin. These are speculations, of course, even though we have some laboratory evidence on the nature of the rocks in the mantle. In the laboratory for instance, peridotite rocks have given the same seismic velocities which we observe to be propagated in the mantle from earthquake shocks.

To sum up, the reasons for drilling to the mantle are: firstly, to obtain a sample of the mantle and analyse its composition. Next, we would like to determine whether or not the ocean basins are permanent in nature, and in so doing obtain more information on the history of the Earth. At the same time we must determine the nature of the material above the mantle in order to extend our knowledge of the geochemical history of the Earth and to improve our understanding of the geochemical balance in Nature. These are some of our reasons for undertaking the project, and to students of the Earth they are very important.

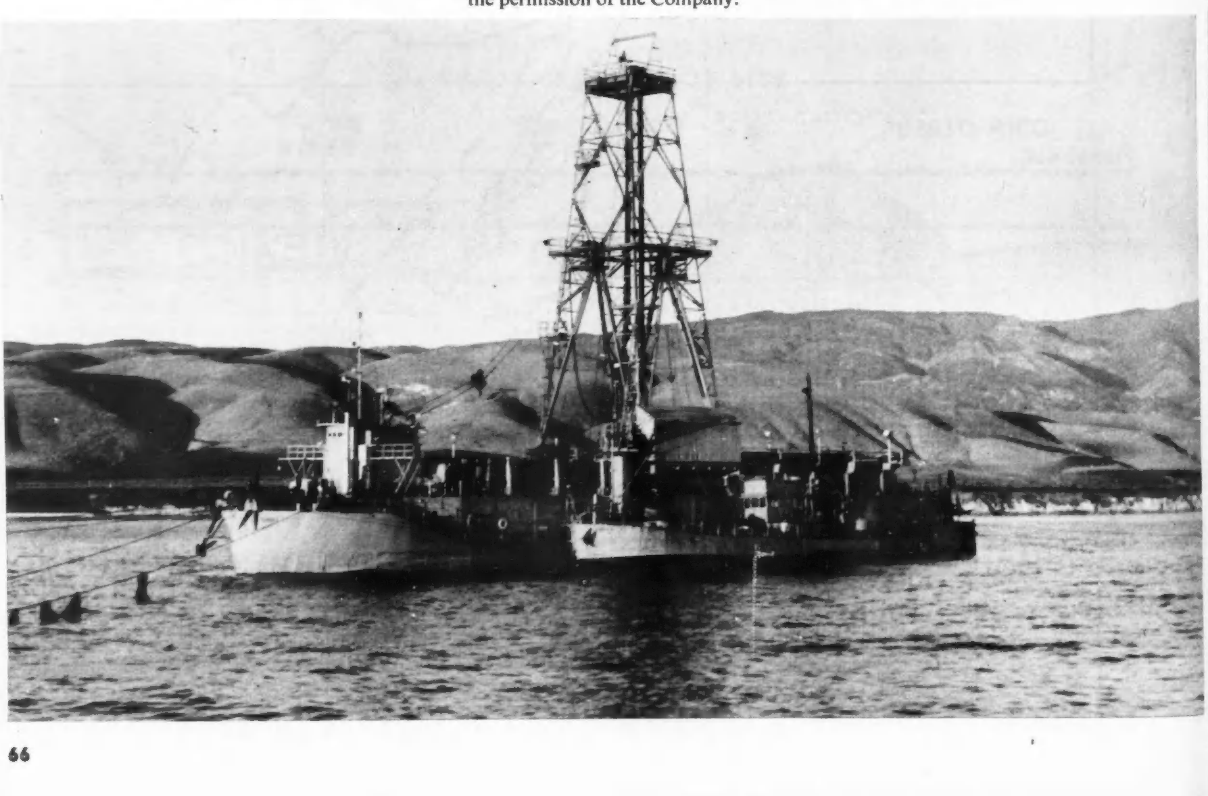
CHOOSING A SITE

One of the most worrisome problems we face in our project is the determination of the proper site for drilling the hole. There are two overriding considerations. One is the weather and related oceanic conditions at the site, and the other is the certainty of drilling where we can reach the mantle. One site which is now being examined is presented in Fig. 4. Four ships worked during June of 1959 in the area labelled "area of survey". They were the *Vema* and *Gibbs* from Columbia University, the *Bear* from the Woods Hole Oceanographic Institution, and the *Hidalgo* from Texas A. and M. College. The scientists on these ships studied the waves and currents, shot seismic profiles, measured gravity and heat flow, and sampled the sediments. The work was quite detailed, and it will be some time before we have the analysed results.

A cross-section of the area north of Puerto Rico which was worked out by scientists at Columbia University is presented in Fig. 5, based on information already obtained. Dr W. Maurice Ewing, Dr Jack Nafe, and their associates, Dr J. Lamar Worzel and Dr Bruce Heezen, are to be complimented on the excellent work they have done in the Puerto Rican area. At the point labelled "Moho" you will note that the mantle comes up just north of the Trench. It is this fact which may make it possible for us to reach it by drilling. The water in this area is about 15,000 ft. deep, and indications are that we may reach the mantle by drilling to a depth of between 30,000 and 35,000 ft. below sea-level.

There are secondary considerations in site selection. The area should be within reach of a good port, so that logistic costs will not be too high. We want to drill in an area that is not unique geologically, but gives as general a picture as possible of the ocean basin. We must determine the heat flow out of the crust at the drilling site. From this we can deduce the temperatures at the bottom of the crust which must not be so high as to overheat the drill bits and inter-

FIG. 7. Deep Sea Drilling Barge, *Cuss-I*. Owned and operated by The Global Marine Exploration Company of Los Angeles, California, the *Cuss-I* represents one type of barge that can be modified for preliminary drilling in 12,000 to 15,000 ft. of water. It is shown here as an example with the permission of the Company.



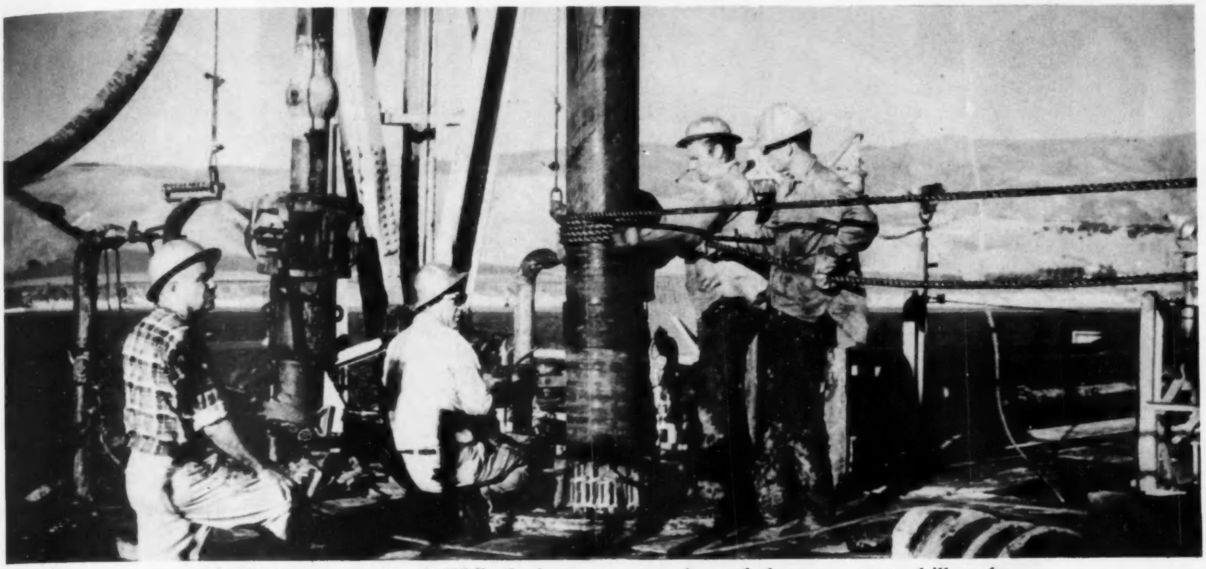


FIG. 8. Deck scene on *Cuss-I*. While the barge can never be made large enough to drill to the Moho, the scene shown here is typical of the type of activity that will be seen when the Moho drilling begins on a new, specially designed barge. Here the crew is adding a new section of drill stem.

fere with scientific measurements in the hole. We hope to choose a site where the temperatures will not exceed 150° to 175°C.

A large area in the Pacific Ocean which encompasses Guadalupe and Clipperton Islands is shown in Fig. 6. This area also offers possibilities for drilling. In July 1959, scientists on the research ships *Spencer F. Baird* and *Horizon* from the Scripps Institution of Oceanography initiated investigations to determine the suitability of the region for our purposes. Their work consisted of the same types of observations as have been mentioned for the Atlantic Ocean. Since the area is much larger it will take somewhat longer to check it. The work at Scripps is proceeding under the direction of Dr George Shor and Dr Russ Raitt.

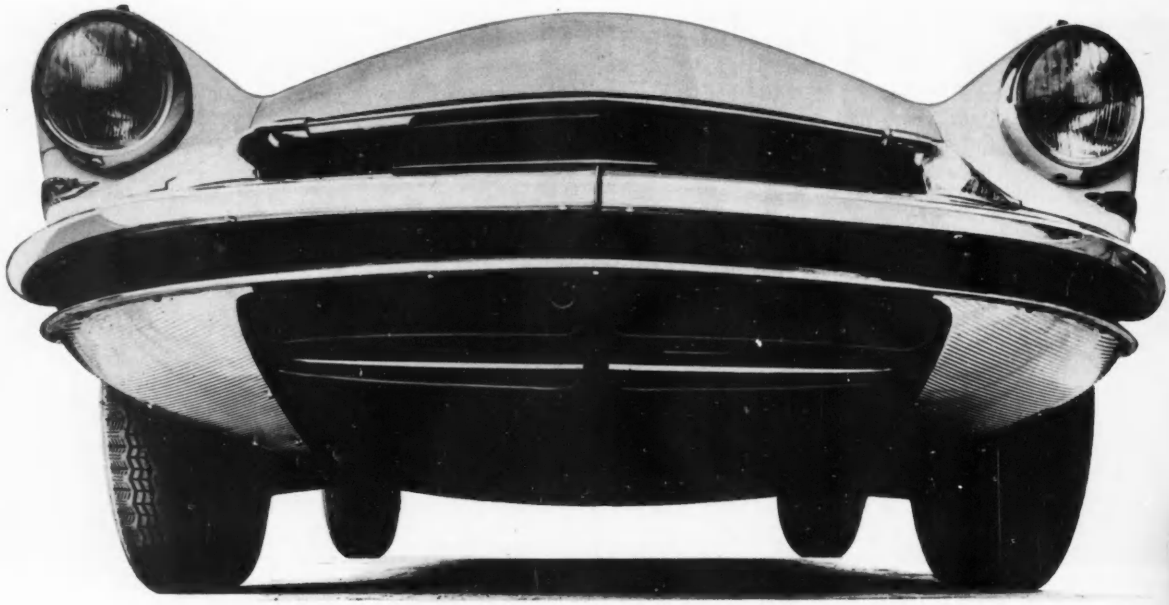
In making plans for drilling the hole we are now fairly satisfied that more or less standard drilling techniques may be used, just as in drilling for oil offshore. It is true that there is no rig in existence which will drill over the deep ocean to the depth required, but it seems possible that such a rig can be constructed. Fig. 7 is a photograph of a typical offshore drilling barge which could be modified, with heavier equipment, to do at least a part of our project. With such modification we could, for example, core the sediments of the Pacific Ocean, and probably continue through the second layer. This would take us to a depth of 18,000 to 20,000 ft. below sea-level. We plan to undertake this type of operation in order to gain engineering information which can be used in the construction of a new and larger rig. We must also obtain data about oceanic conditions at depth and their effect upon our drilling barge. The scientific information gained during this preliminary phase will be invaluable. Fig. 8 is a photograph of one of the offshore drilling barges in operation. It is our intention to core the entire section from the surface to the mantle, and if we run into bad luck it may take as long as a year to complete the hole.

We are not yet certain when we will be able to begin actual drilling to the mantle. At the earliest, depending upon how soon we can get financial backing, we may be ready to begin some time in 1961. This date also depends upon our success in gathering design criteria through actual practice at sea. With luck, and the continued interest in our project on the part of scientists and industrialists, we should be able to complete the drilling towards the end of 1963. At that time we will have several years of data analysis to look forward to before the complete effect of our project on geology and geophysics is felt.

RUSSIAN ACTIVITY

As usual in large projects of this sort, the question has arisen what the Russians are doing about deep drilling. It is really quite difficult to tell what they are doing; however, we do have a few facts which are of interest, even though we are not engaged in a race for the mantle.

At the Eleventh General Assembly of the International Union of Geodesy and Geophysics held in Toronto, Canada, in September 1957, a resolution was adopted endorsing the objectives of this deep-drilling project. The Russian delegates were in hearty agreement with the resolution, and at that time announced that they had the equipment and ability to do the job. Subsequently, we have learned that there is a special branch of the Soviet Academy of Sciences located at Novosibirsk which is dedicated to the problems of deep drilling. The branch is headed by Mikail A. Lavrentyev, but we have no information about their activities. We have learned through the scientific literature that the Russian research ship *Vityaz* has recently completed two seismic profiles in the Sea of Japan, where they found a depth to the mantle of about 30,000 ft. We are not certain that this activity has anything to do with a deep-drilling project by the Russians, but it looks as though the Sea of Japan might be a reasonable place for them to drill.



HYDRAULICS IN THE MOTOR-CAR

M. SAINTURAT

Ingénieur des Arts et Métiers, M.I.Mech.E., M.S.A.E, Chief Engineer, Citroën Research Department

Hydraulic brakes and suspension, hydraulic transmission, power-assisted steering—every year sees new applications of hydraulics to automobile design. In France these developments have reached their peak in the all-hydraulic Citroën car.

It is already more than twenty-five years since hydraulics made their appearance in the motor-car with the first four-wheel brake control. At approximately the same time hydraulic transmission was introduced, first in the form of a clutch combined with a pre-selector gearbox with planetary trains of the Wilson type (Daimler, 1930), and later in the form of torque converters, also combined with gearboxes. Today, after long and careful development, gearboxes with torque converters aim at an ideal performance and refinement in the field of auto-transmission. Other applications include the use of power-assisted steering (already well established, especially in the United States). All this has been leading to the 100% hydraulic car.

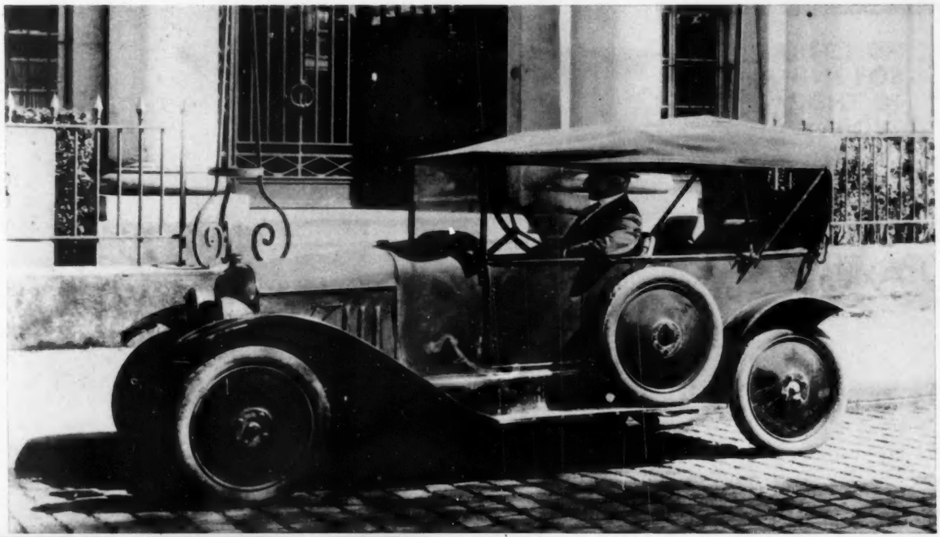
APPLICATIONS OF HYDRAULICS

Many cars built since 1930 have hydraulic brakes, and about 14 million have been produced with hydraulic transmission. The improvement of the brake system for safety and efficiency quite naturally linked its control with the suspension system. Before we discuss the use of the brake/suspension mechanism, however, let us first review applications to transmission.

Historically, hydraulic converters preceded clutches. The Föttinger patent dates from 1904, and converters were first produced in 1908 (reduction gear for propeller shafts), while the first clutch, the invention of a follower of Föttinger, dates from 1920, and was first used in a car by Daimler in 1930.

The clutch creates a hydrokinetic link between the primary and secondary shafts (which are aligned), the transmitted torque being proportional to the square of speed. It therefore de-clutches the engine when the torque exerted by the engine is smaller than the torque exerted by the car resistance. It thus allows one to dispense with the clutch pedal and to apply the engine torque as progressively as may be required. In addition, it very effectively damps vibrations. Its efficiency, obviously zero when the car is stationary, would in principle, like that of a friction clutch, reach unity when the vehicle's speed matches that of the engine. In practice, however, a minimum slip between the primary and secondary is required for transmitting the torque. In a well-designed machine, efficiency can reach 97%.

The torque converter is based on similar principles, with the addition of reactor blades, which ensure that the oil leaving the driven member is redirected to the pumping element or "impeller". The reactor blades being fixed, an increase of the output torque is possible, and this can reach a high rate on starting (with zero efficiency). The ratio of the primary and secondary torques diminishes as the output speed increases, and efficiency rises to a maximum. As speed increases beyond this maximum, the ratio of the torques diminishes towards zero, as does the efficiency for a given velocity ratio. For this reason the converter is always linked by hydraulic coupling, which is brought into play as soon as the speed reaches the level where transmitted torque can increase no further. This occurs at a slightly



FIGS. 1, 2, 3. The firm of Citroën has always been in the forefront of automobile engineering, and since its first car, made in 1919 (*see above*), has pioneered the famous 11 h.p. "front-wheel drive" (1934) (*left*). The most famous pioneering effort was probably *La Croisière Noire* during 1924–5 on half-tracked vehicles across Africa from Algiers to Madagascar. The illustrations show them in the desert between Colomb-Béchar and Béni-Abbès.

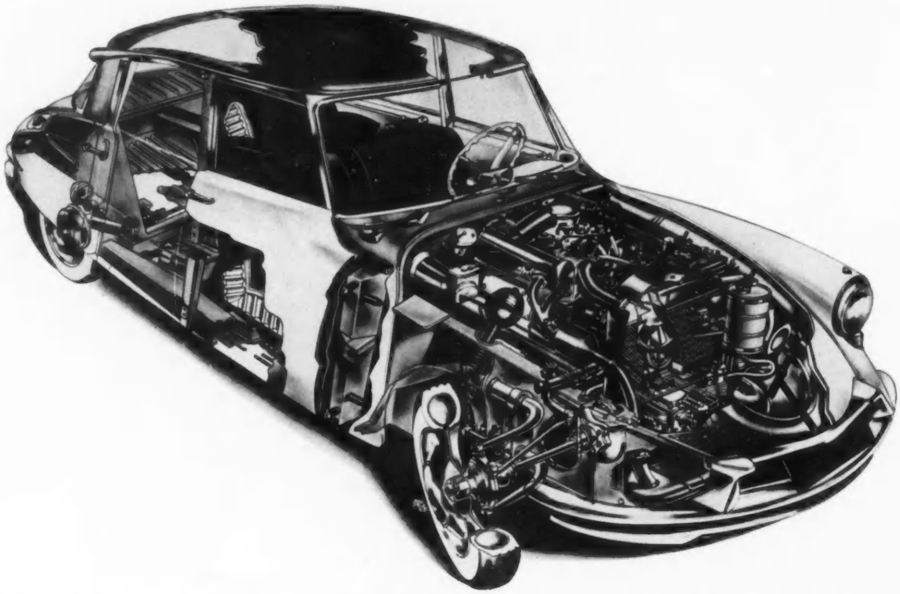


FIG. 4. A cut-away drawing of the New Citroën motor-car with hydropneumatic suspension.

higher speed than that of maximum efficiency, so that when almost equal to the maximum of the converter, efficiency is again increased when the coupling is brought into action. From this point onwards primary and secondary torques are equal.

After much development work, the use of several stages and the introduction of variable-pitch blades have increased the efficiency of the converter to 90%, or slightly higher.

Rather than further efforts to break this record the present tendency is to try to achieve the highest efficiency by making the most rational use of two or more gear stages —usually three. Most impressive are the latest Buick and Chevrolet models, fitted with Dynaflow and Powerglide transmission respectively.

First used in Cadillac, Oldsmobile and Pontiac and then incorporated into the Rolls-Royce transmission system, the renowned HydraMatic transmission has no converter. It consists of a four-stage planetary gearbox combined with a hydraulic clutch in front. The latest design includes an auxiliary coupling with rapid emptying and filling device, which controls speed changes and eliminates any lack of continuity in torque transmission. It is, in short, a highly perfected version of the original Daimler gearbox. Transmission of this kind ensures minimum loss of power, but is, unfortunately, expensive. A simpler solution for the gearbox with converter is found in a recent Rover model.

Hydrokinetic gearboxes (with torque converters) are controlled by oil pumped under pressure on to small pistons actuating the clutches or brakes of the planetary gear train, and in Europe the development of these devices is associated with petrol economy. Incidentally, because of their lower efficiency when compared with gears, it is tempting to increase power considerably, not to make the car more flexible but to prevent its driver feeling handicapped beside the driver using a conventional gearbox.

Those hydraulic mechanisms which are not simply slaves but are to some extent autonomous, incorporate the fuel-injection system of the engine. Satisfactory performance then depends on high-precision engineering, specially treated materials, and, of course, a faultless design. This, in turn, must be based on the physics of liquids at high pressure and take into account elastic wave propagation in the tubes linking the hydraulic system to the injection.

Hydraulic tappets, now so much more common on account of the development of the V8 engine in the United States, present an example of parts requiring a very high degree of precision, of the same order as that of fuel-injection systems. Besides allowing nearly zero clearance between the rocker arms and the valve stems, such tappets offer the threefold advantage of ensuring very silent engine running at low speeds; better valve cooling, by increasing to the maximum the length of contact with the seat; and the elimination of complicated adjustments (sixteen in all), due, in the majority of multi-cylinder V engines, to the inaccessibility of valves.

Turning now to heavier vehicles, all tipping lorries have a mechanism for manoeuvring the tip which invariably uses a hydraulic ram fed by an oil pump driven by the engine. Rubbish-carts in certain large towns, such as Paris, control the rammer by hydraulic transmission comprising two geared pumps, one for feeding and one for driving. There is also the well known multiple tool-lifting system with which agricultural tractors, and in particular the Ferguson, are equipped.

HYDROPNEUMATIC SUSPENSION

We now come to the brake/suspension system invented and perfected by Citroën. The work to improve the brake system had as its ultimate aim the introduction of power assistance, or its equivalent, in the form of stored potential energy controlled by pedal action, to reduce the effort required from the driver. But this alone was not enough, for ever greater safety requirements demanded the total use of adhesive weight, whose distribution, as every driver knows, varies with the deceleration rate. It was therefore necessary to control the braking distribution automatically in proportion to the adhesive weight distribution, which in its turn affects the suspension.

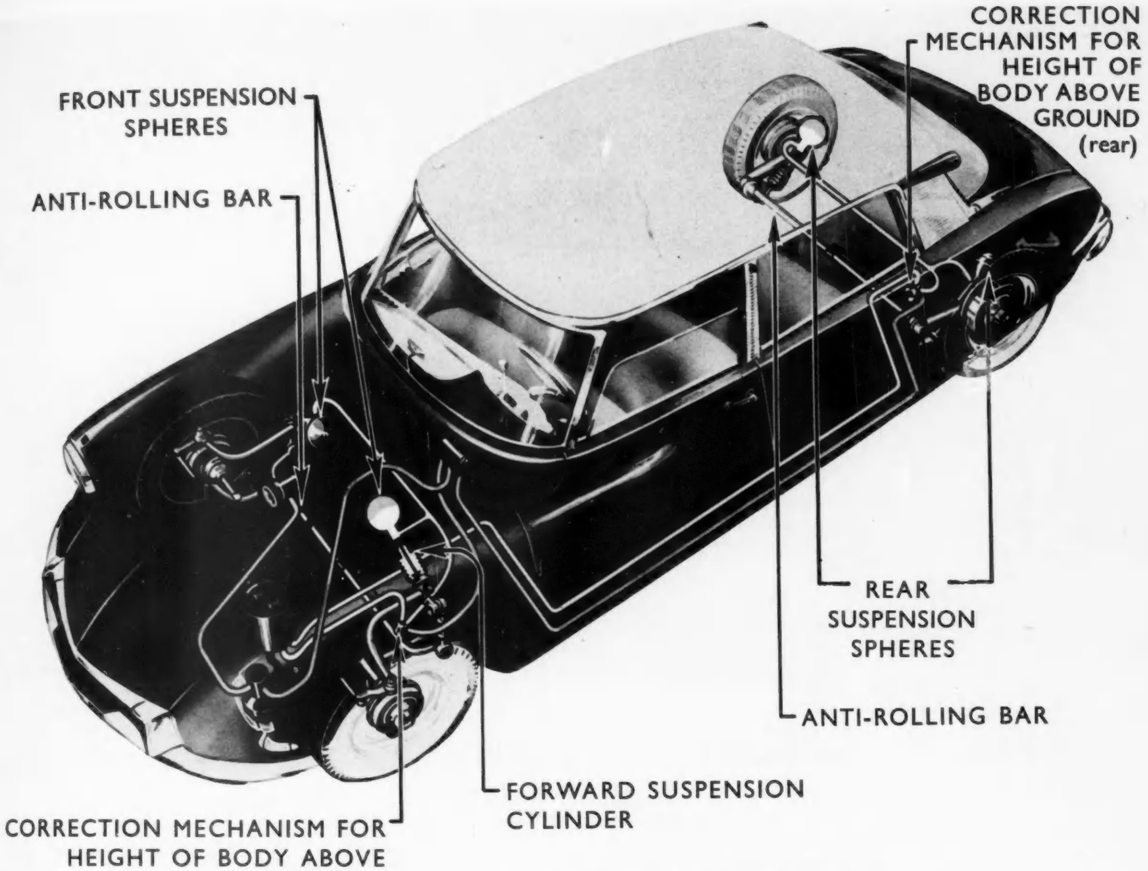


FIG. 5. Diagram of the hydropneumatic suspension.

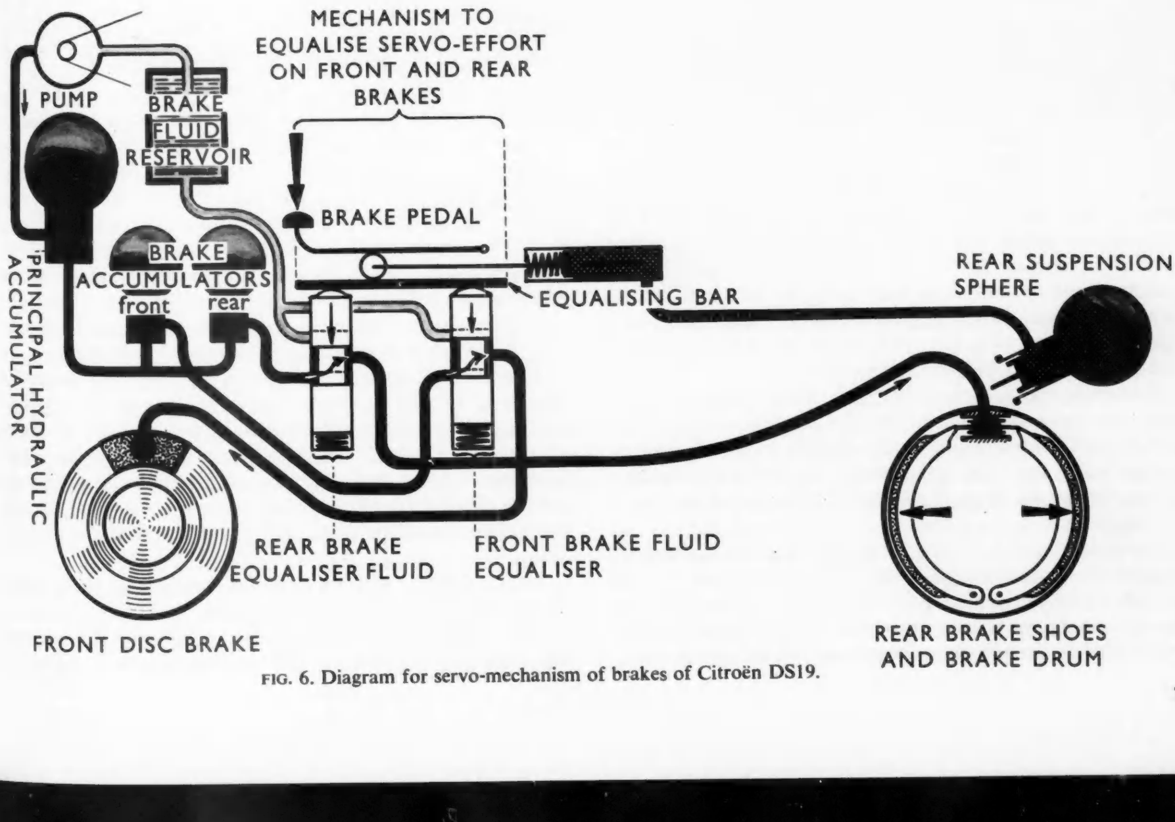


FIG. 6. Diagram for servo-mechanism of brakes of Citroën DS19.

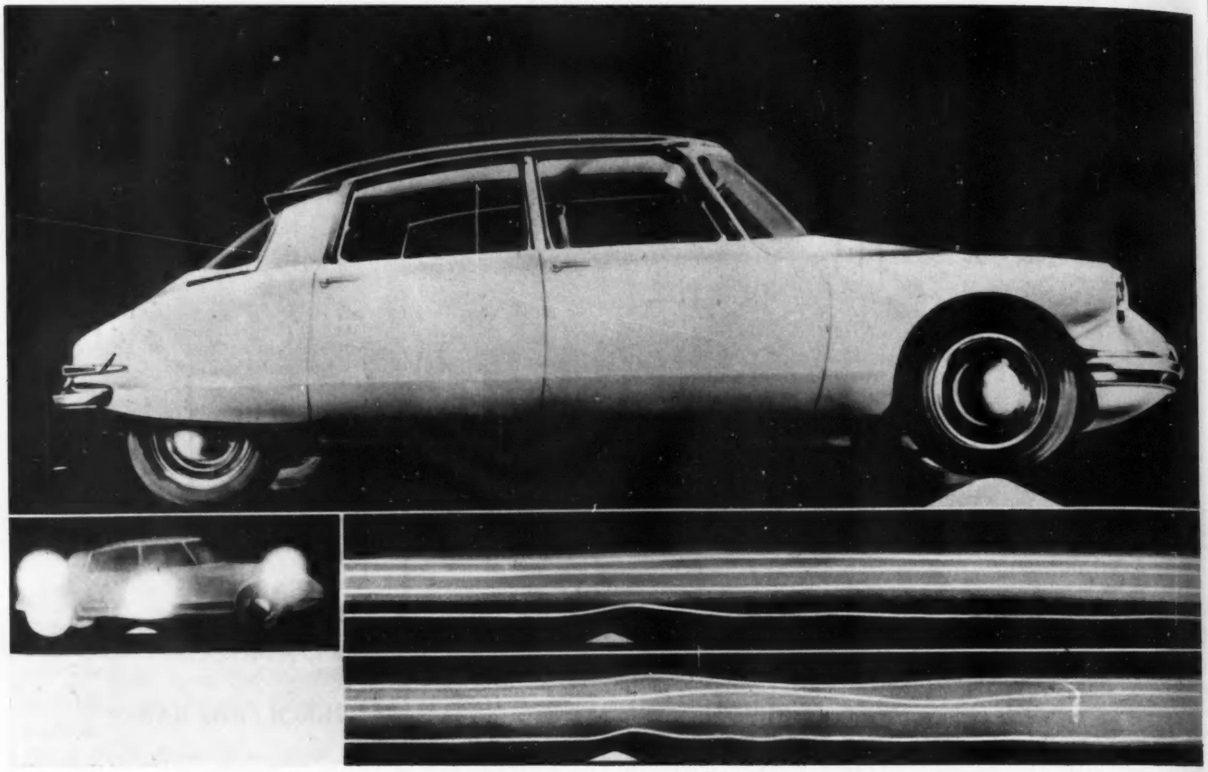


FIG. 7. A research record of the behaviour of a Citroën DS19 car crossing an obstacle on the ground (*top*) compared with the behaviour of a conventional car. Lights are fixed to the side of the car and leave a trace on a photographic film, giving an indication of the movement of the parts of the car during the crossing of an obstacle.

Thus it is evident that maximum safety demanded a braking equaliser which could only be controlled by the suspension. In the Citroën this equaliser is made very simply by a compensating lever whose point of support moves under the direct action of gas pressure in the rear suspension assembly.

On the other hand, it is held that perfected suspension from the threefold point of view of aesthetics, comfort, and safety must include a device to maintain a constant average distance from the ground. This device must, of course, be adaptable to other requirements: maximum but controlled flexibility, limiting the variations in acceleration to the minimum compatible with the clearance allowed by the shape of the car, these depending upon load, speed, and state of the road. We see the complexity of the problems raised by brake/suspension interaction.

Therefore, though other methods than hydraulics may carry out some measure of control in brake/suspension interaction, the idea of the "hydraulic power-plant" appears at once to be the ideal solution for the brake/suspension system, before we even consider the other applications of hydraulics.

This centralisation of two essential functions leads us to consider the possibility of mechanisms which will behave as if they had an intelligence of their own. They take the place of the driver in carrying out controls which, in addition to almost instantaneous response, require great power and accuracy of movement, and they do this with an efficiency of which no driver is capable.

THE APOTHEOSIS OF HYDRAULICS

The centre of this control has been called the "mechanical heart". It is a high-pressure oil pump maintaining the necessary reservoir of potential energy at the required level in the form of a compressed gas accumulator (nitrogen). In fact, this pump, like a heart, maintains controlled circulation through a make-and-break valve in a network comprising damping tank, accumulator, and suspension blocks. The damping is achieved by the viscosity of the oil as it flows in both directions through a tube. This tube joins the cylinder to the spheres containing the gas and oil which are separated by a rubber membrane.

The average distance of the body from the ground is regulated at the front and the rear by correctors which automatically restore the balance by modifying the volume of the linking liquid in the corresponding blocks, either injecting it from the accumulator or emptying it into the reserve fluid tank. The return to the tank from the discharge and overflow thus completes the distribution network.

Such a system permits great flexibility near the position of equilibrium, as well as clearances compatible with the linkage geometry by means of automatic and lasting adaptation to circumstances, together with an extremely

FIG. 8. The famous Citroën 2 h.p. car, the 2 C.V., is now modified to contain two engines, one front and one rear, driving respectively the front and rear wheels; the carburettor controls of the two engines are linked. This car is still in the early experimental stages and is offered for extreme driving conditions, such as are being found in the Sahara, where four-wheel drive is essential. To solve this specification by the use of two entirely independent engines is a novel approach and the results of field trials will be awaited with great interest.

efficacious shock-absorbing system, which ensures maximum safety on account of road-holding characteristics no longer restricted by flexibility.

From this brief account we may conclude that hydraulics allow particularly effective brake/suspension interaction, and that the system developed from what has been called the hydraulic power-plant carries out controls which no driver could be asked to perform. The hydraulic system acts as if endowed with a kind of mechanical intelligence, which, of course, is none other than the translated intelligence of its inventor.

This system can also provide less important but no less attractive amenities, such as jacking the car for wheel changing, or for putting the finishing touches to the body-work: windscreen wipers, window-raising mechanism, and so forth. It all depends upon the degree of comfort desired and the price one is willing to pay for it.

We believe that the co-ordination thus obtained is the true apotheosis of hydraulics. For the first time they have made possible a highly desirable combination of absolute safety at very high speeds and a remarkable degree of comfort no longer dependent upon variations of load and speed. Safety requires a road-holding capacity, which is not sacrificed to comfort, and also an optimum use of brakes, and these two factors are interdependent. Any mechanical substitute would certainly be more complicated, entailing difficulties of adjustment, and would probably be more expensive.

LIQUID HYDROGEN FOR CHEMICAL AND NUCLEAR ROCKETS

R. B. SCOTT

Chief, Cryogenic Engineering Laboratory, National Bureau of Standards, Boulder, Colorado, U.S.A.

Although liquid hydrogen has been known for over sixty years it has, until now, remained a laboratory curiosity. Large-scale manufacture of liquid hydrogen has just been achieved in America, where it is used as a fuel for chemical rockets and in the future for nuclear rockets.

On May 10, 1959, Lieutenant-General Bernard A. Shriever, Chief of the U.S. Air Force Air Research and Development Command, announced the use of liquid hydrogen as a rocket fuel, thus bringing to public attention a programme that had been started several years earlier. Long before this the theoretical performance of liquid hydrogen, when combined with liquid oxygen in a rocket motor, had been computed, and it was known that this combination was distinctly superior to the hydrocarbon-liquid oxygen propellants normally used, when compared on the basis of equal weights of propellant. The hydrogen-oxygen combination will deliver much greater thrust for a given rate of consumption of propellant. However, liquid hydrogen has two disadvantages—high volatility and low density. Liquid hydrogen is very cold, boiling at −423°F (20·4°K), and has a small heat of vaporisation. Thus, very well insulated tanks are needed for storage and transportation, and at least a moderate amount of insulation is required on the rocket tank itself. The low density calls for tanks having more than twice the volume of the tanks needed for an equal weight of hydrocarbon-oxygen propellant. These drawbacks certainly delayed the use of liquid hydrogen in rocketry.

Another deterrent, perhaps of equal importance, was the fact that liquid hydrogen had not been produced and handled in large quantities. This situation began to change in 1952 when the National Bureau of Standards' Cryogenic Engineering Laboratory was established at Boulder, Colorado, to produce large quantities of liquid hydrogen, and to conduct research in engineering and applied physics in support of a project of the Atomic Energy Commission, involving the application of cryogenic techniques. The hydrogen liquefier produced 350 litres/hour of liquid normal hydrogen, or 240 litres/hour of liquid parahydrogen. With this liquefier it was not difficult to supply several thousand litres of liquid hydrogen for a single experiment, so the means for acquiring the necessary knowledge was at hand. The large-scale experimentation and testing which followed paved the way for using liquid hydrogen in rocket engines.

Although this liquefier was large compared with liquefiers used in physics and chemistry laboratories, it could not supply the huge quantities needed for actual rocket engine testing. General Shriever's announcement told of "large tonnage" production by a plant located in Florida. There is a picture of this plant in the June, 1959, issue of *Chemical Engineering Progress.*

PRINCIPLE OF LIQUEFACTION

The essentials of the liquefaction process used in the NBS liquefier are very similar to those employed by Sir James Dewar in 1898, when he succeeded in liquefying hydrogen for the first time. Hydrogen is compressed to 100 atmospheres, purified, divided into two streams, and admitted to two counterflow heat exchangers at the top of the liquefier. These heat exchangers consist of coils of copper tubing carrying the high-pressure hydrogen downward, while, filtering upward in the spaces between the tubes, is cold, low-pressure gas. One of the streams of cold gas is the unliquefied hydrogen returning to the compressor; the other is nitrogen which has evaporated from the liquid nitrogen pre-cooling bath. Thus the incoming high-pressure hydrogen is progressively cooled by the outgoing cold low-pressure gas, and refrigeration is conserved. This is the function of the counterflow heat exchanger, to remove heat from the incoming warm fluid stream, and save the refrigeration that has been produced. After traversing these two heat exchangers, the hydrogen streams reunite and pass through a coil immersed in liquid nitrogen where the temperature is reduced to about 65°K. To obtain this temperature, the pressure over the liquid nitrogen is reduced by pumping the returning nitrogen vapour through large vacuum pumps. The high-pressure hydrogen at 65°K then passes into the final heat exchanger, where it is further cooled by the low-pressure unliquefied hydrogen. At the bottom of this heat exchanger the hydrogen expands through a valve to a pressure a little above atmospheric.

FIG. 1. This insulated trailer for highway transportation of liquid hydrogen has a capacity of 6000 U.S. gallons. Many trailers of this type are used to carry liquid hydrogen from the liquefiers to test sites.
(By courtesy of Beech Aircraft Corporation)

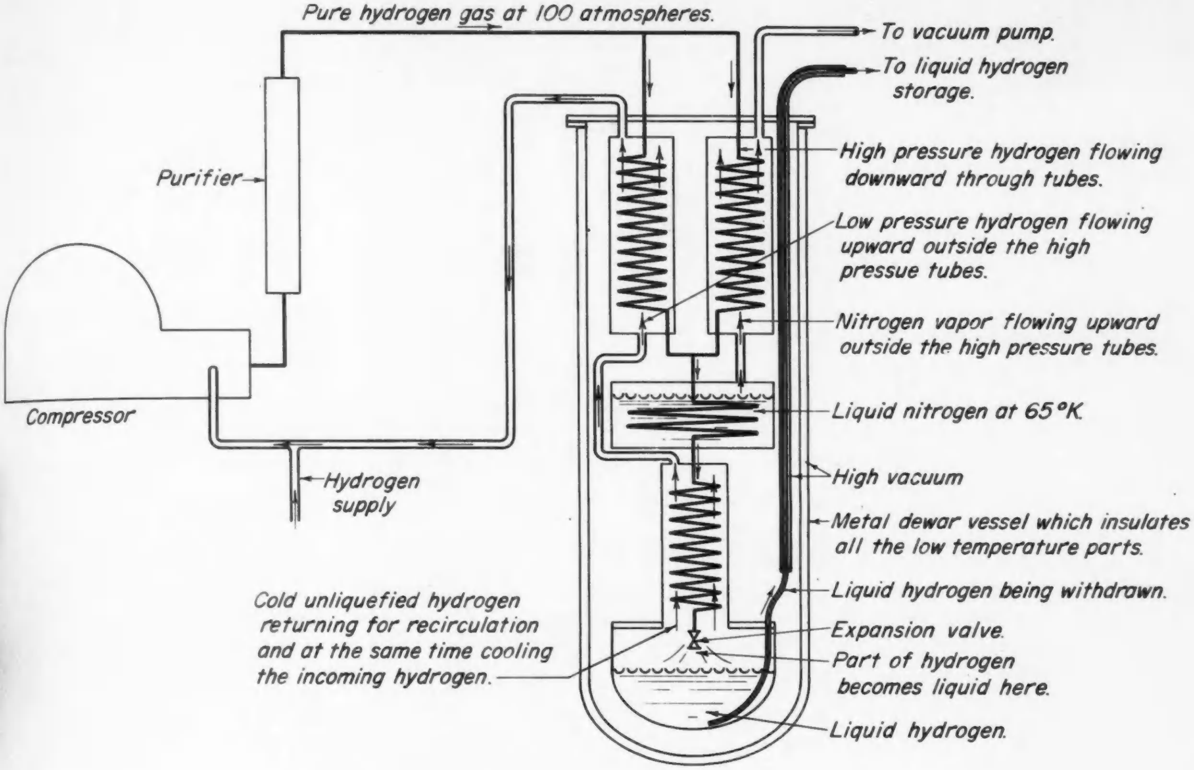


FIG. 2. **A schematic diagram of a Joule-Thomson hydrogen liquefier.**

This expansion reduces the temperature to about 21°K and causes approximately 20% of the hydrogen to liquefy. The unliquefied hydrogen passes back through the low-pressure passages of the heat exchangers and cools the incoming high-pressure hydrogen.

This is called the Joule-Thomson process of gas liquefaction because the cooling is caused by the Joule-Thomson effect—that is the reduction of temperature which accompanies the expansion of a gas through a valve or orifice. It will be noted that the cycle also includes a pre-cooling chamber in which the hydrogen is cooled to the temperature of liquid nitrogen. This is very necessary in this liquefaction system because if hydrogen expands at ordinary temperatures, the expansion is accompanied by a rise of temperature; that is, the Joule-Thomson effect is negative. The temperature at which an expansion produces neither heating nor cooling is called the Joule-Thomson inversion temperature. Only by pre-cooling the hydrogen below the inversion temperature can further cooling and liquefaction be accomplished by the final heat exchanger and expansion valve.

Liquefiers have been designed in which a large part of the cooling is obtained by expanding all or part of the gas through an *expansion engine*. The expansion engine may be either a reciprocating engine (like a steam engine) or a turbine. In either case this part of the cycle can be very efficient because nearly all the work produced by the engine can be transferred completely out of the liquefaction system, with the result that there is much greater cooling than is accomplished by the simple Joule-Thomson expansion which produces no work. Moreover, cooling with an expansion engine is not limited by the Joule-Thomson inversion temperature. The expansion engine is effective at any temperature. The disadvantage of expansion engines is the requirement for moving parts at low temperatures. Expansion engines are most advantageous in very large liquefiers because, in this case, the cost of the power required to drive the compressors is a large fraction of the total operating cost. The use of expansion engines greatly reduces this cost by increasing the efficiency of the cooling process. The principal cost of operating small liquefiers is the wages of operators.

PROPERTIES OF LIQUID HYDROGEN

Liquid hydrogen has some curious properties, one of which, low density, was mentioned earlier. The density of liquid hydrogen is only 1/14th that of water. Actually, a gallon of water (H_2O) contains about 56% more hydrogen than does a gallon of pure liquid hydrogen. However, the molar volumes of liquid hydrogen and liquid oxygen are very nearly equal. That is, equal volumes of liquid hydrogen and liquid oxygen contain very nearly the same number of molecules. This means that the liquid hydrogen tank of a hydrogen-oxygen rocket should have twice the volume of the oxygen tank if the fuel-oxidant mixture is adjusted to stoichiometric proportions so that the product of combustion will be steam, H_2O.

Another unusual property of hydrogen is the existence of

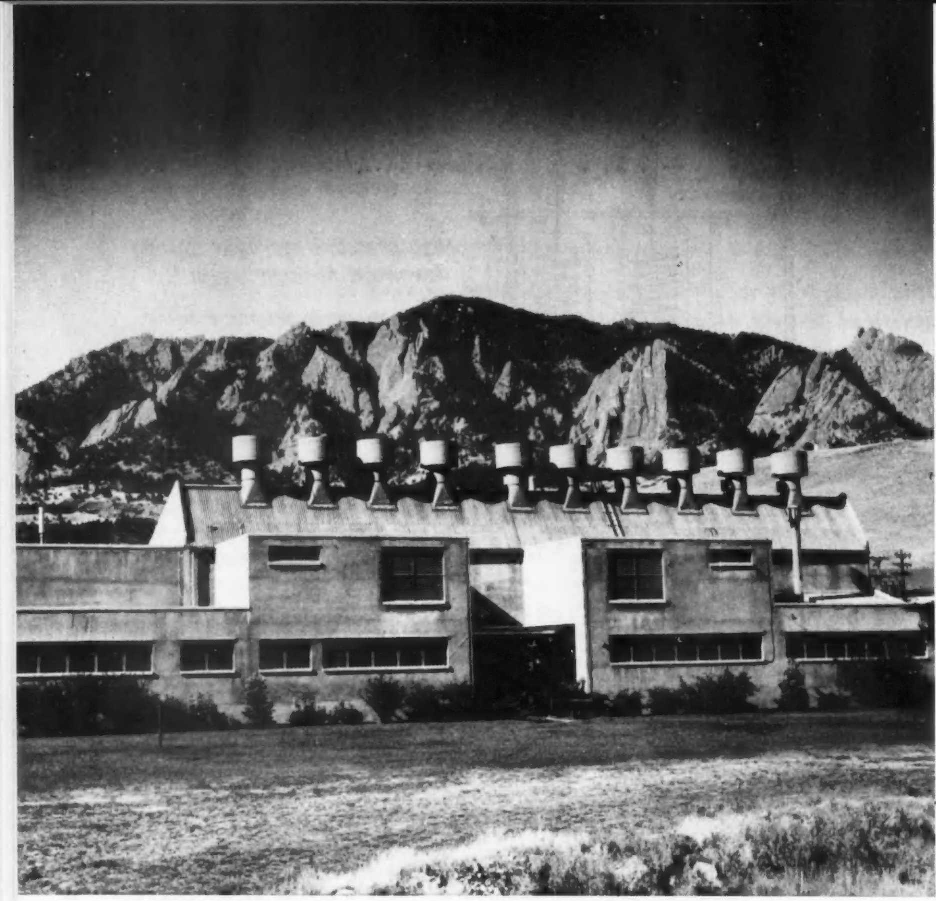


FIG. 3. This building houses the gas liquefaction equipment of the National Bureau of Standards' Cryogenic Engineering Laboratory at Boulder, Colorado. Ventilators on the roof prevent dangerous concentrations of hydrogen. Foothills of the Rocky Mountains are in the background.

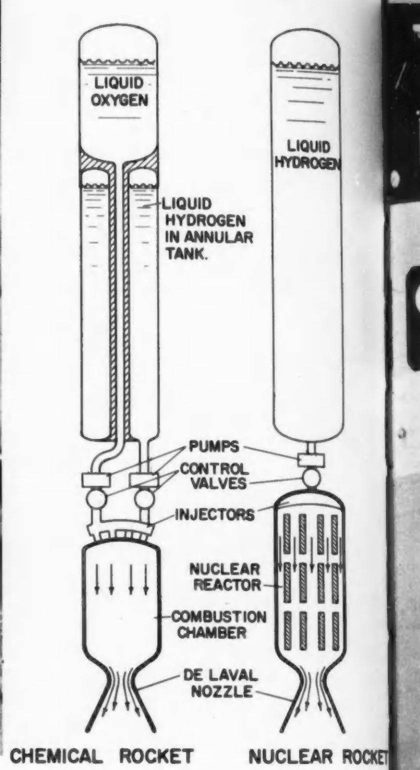


FIG. 4. Schematic diagrams of rockets using liquid hydrogen.

two molecular varieties, orthohydrogen and parahydrogen, characterised by the relative orientation of the spins of the two nuclei of the diatomic molecule, H_2. In orthohydrogen, the nuclear spins are in the same direction, while in parahydrogen they are in opposite directions. The high-temperature equilibrium composition, closely approached at room temperature and known as *normal* hydrogen, is 75% orthohydrogen and 25% parahydrogen. At the boiling-point of liquid hydrogen, 20·4°K, the equilibrium mixture consists of 0·21% orthohydrogen and 99·79% parahydrogen. This large change in equilibrium composition has an important consequence in storing liquid hydrogen. When hydrogen is liquefied in the usual way, there is little change in the ortho-para composition, so, if *normal* hydrogen is admitted to the liquefier, the liquid product is very nearly 75% orthohydrogen and 25% parahydrogen. Now, if this liquid is stored, there is a gradual conversion to the low-temperature equilibrium concentration *with the evolution of heat*. This heat of conversion will evaporate the liquid at an initial rate of about 1% per hour. Consequently, liquid *normal* hydrogen has very poor keeping qualities. This loss can be avoided by producing equilibrium hydrogen (99·79% para) in the liquefier. Present-day hydrogen liquefiers produce liquid having a para concentration of 95% or more. This is accomplished by catalysts in the liquefier which speed the conversion. Of course, the heat of conversion imposes an extra burden on the liquefier, so the liquefaction rate is reduced. The catalyst most favoured at present is a hydrous ferric oxide gel, having a large surface area upon which conversion takes place. This catalyst was developed by the National Bureau of Standards in research associated with the large-scale production and storage of liquid hydrogen. The liquid parahydrogen produced in this way can be stored in good vessels with a loss of less than 1% per day.

CHEMICAL ROCKET FUEL

We shall now consider the reasons for the superior performance of rockets fuelled with liquid hydrogen. It might be assumed that the improvement results from the greater heat of combustion of hydrogen. However, this is the lesser of two influences. A more important factor is the density of the exhaust gases. When an ordinary petroleum hydrocarbon is burned with oxygen, the exhaust gas has an average molecular weight of about 35. When hydrogen is burned, the molecular weight of the product (H_2O) is 18. Since the energy (or heat of combustion) is not greatly different in the two cases, and the density of the exhaust gas is very nearly proportional to the molecular weight, the H_2O is ejected through the rocket nozzles with a considerably greater velocity. We can use the elementary physics formula, $E=\frac{1}{2}MV^2$ to compute the theoretical velocity of the exhaust gas. E is the average energy that each molecule has by virtue of its mass, M, and exhaust velocity,

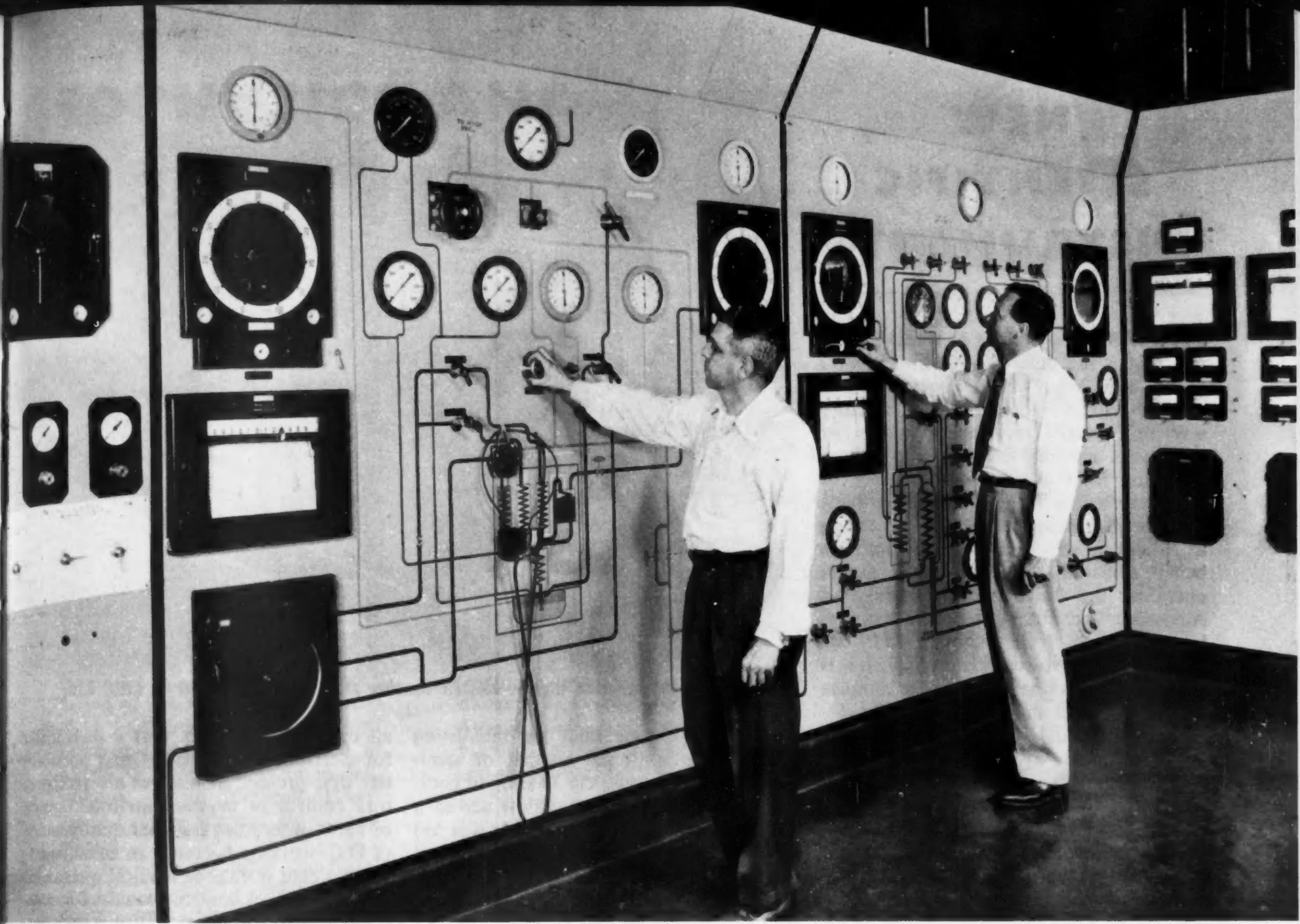


FIG. 5. The control panel of the large hydrogen liquefier of the National Bureau of Standards.

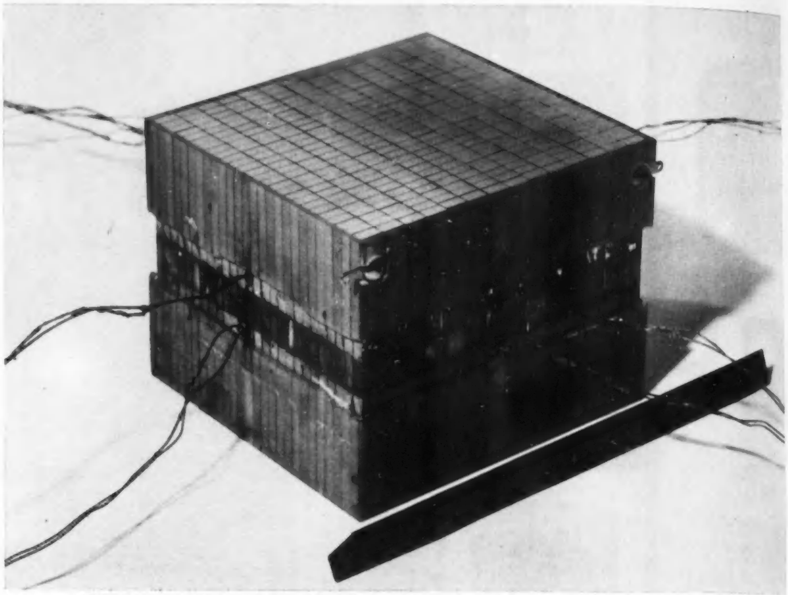
V; M is the molecular weight; and V is the relative velocity of the exhaust gas. Thus for a given energy, it is apparent that the velocity, V, is proportional to $\sqrt{1/M}$. Now the thrust produced by ejecting the exhaust gas is (by Newton's second law) equal to the rate of change of momentum. Conservation of momentum dictates that this rate of change of momentum is exactly the same for the rocket as it is for the escaping exhaust gas. Therefore, for a given energy, the thrust is proportional to mV, or to $m\sqrt{1/M}$, where m is the rate of consumption of propellant and M is the average molecular weight of the exhaust gas. Thus, it is very advantageous to have exhaust gas of low molecular weight. This argument is greatly over simplified because it does not take into account the other forms of energy that a molecule may have—vibrational and rotational energies which do not add to the molecular velocity. However, the inclusion of these energies would only strengthen the case for a propellant of low molecular weight, because the lightweight molecules are of simpler structure and a greater fraction of their total energy is accounted for by their velocity.

A study of the theoretical performance of hydrogen-oxygen rocket propulsion engines gives even greater emphasis to the advantage of low-density exhaust gas. It was found that hydrogen-rich mixtures give better performance than does the stoichiometric proportion, two atoms of hydrogen to one of oxygen. Even though the energy per unit mass is reduced, the lower average molecular weight of the exhaust gas more than compensates, so the thrust produced by a given mass-rate of consumption of propellant is increased by injecting an excess of hydrogen and expelling some of the hydrogen unburned.

NUCLEAR ROCKET FUEL

In the nuclear-powered rocket now under development, there is complete freedom of choice in deciding what material to use as the propellant. In this rocket, nuclear fission furnishes the power to heat and eject the propellant. Since hydrogen is the lightest of gases, and therefore will provide the greatest exhaust velocity for a given energy, liquid hydrogen has been selected as the propellant. The advantage of the use of liquid hydrogen in a nuclear-powered rocket is even more pronounced than in the case of the chemical rocket. We can, for example, compare the theoretical performance of liquid hydrogen and water in a nuclear rocket. Water, H_2O, has a molecular weight of 18, while hydrogen, H_2, has a molecular weight of 2. Therefore, for a given amount of energy, the ratio of the exhaust velocities, hydrogen : water (steam), will be $\sqrt{18/2}=3$, so a given mass of hydrogen will provide three times the thrust of an equal mass of water. Hydrogen, being the lightest element, is the logical choice for the propellant, and it must be in the liquid state in order that a large amount may be carried in a light-weight tank.

NEW SCIENTIFIC INSTRUMENTS



The 182-junction thermo-electric cooling assembly constructed by GEC Ltd.

There is growing interest in visual screening, that is the bulk examination of eyes to establish who would benefit from a visit to an ophthalmic optician. Factory screening usually reveals about 40% of employees needing eye-care and school screening finds a significant number of children needing examination. To provide a single instrument capable of screening a patient in three minutes without its being essential to employ an expert operator, the Northampton College of Advanced Technology, London, has collaborated with J. R. Fleming Ltd. The result, called a **Master Vision Screener**, is now on the market. Within three minutes it will carry out the following tests: *distance*: letter visual acuity and detection of hyperopia, each eye separately; vertical and horizontal heterophoria; stereopsis and simultaneous foveal vision with fusion. *Near vision*: letter visual acuity; vertical and horizontal heterophoria; ability to accommodate; visual acuity binocularly; simultaneous foveal vision with fusion and stereopsis. The complete instrument weighs 28 lb. and costs £98.

Instrument engineers will be interested in a new 360° **counter-type indicator.** The presentation of an angle is by a three-figure counter reading to ½° and it is of special value for indicating heading information on navigational equipment. The manufacturers claim that it is the smallest counter of its type and operating torque has been kept to a minimum. It will operate in the temperature range −40°C to +70°C and can withstand a fore-and-aft acceleration of 25 g.

A new instrument for the **detection of explosive gases** has been marketed. Detection is by a variation of the catalytic method. Several catalysts are impregnated in an insulating material which is heated by wire coils which form part of a bridge circuit. The other arm of the bridge is similar but without the catalyst. Unbalance is amplified by a transistor and operates a relay which can sound an alarm or perform any desired switching. The bridge circuit eliminates spurious operation due to either pressure or temperature change. The gas detector has particular applications in boats and is designed to operate from low voltage D.C. supplies, but it also has obvious uses in laboratories. It costs £18 10*s*.

The Peltier effect, discovered in 1834, was nothing more than an interesting phenomenon until the coming of semi-conducting materials. The heating or cooling resulting from current flow across a junction of two dissimilar metals was too small to be of practical significance and was masked by Joule heating. Metals have thermal emf coefficients of the order of 10 μV/°C, but semi-conductors can be made with coefficients hundreds of times greater. At the same time, the thermal conductivity of a semi-conductor can be reduced by alloying with an isomorphous material without reduction of carrier mobility.

Such materials are now being used experimentally for cooling. The General Electric Company have produced an alloy giving a maximum temperature difference of 80°C at a mean temperature of 17°C when the unit is doing no work. When working at reasonable efficiency temperature differences across the couple of 30°C to 50°C are attainable, giving a drop of air temperature in an enclosure of about 25°C. With a second stage a greater degree of cooling is possible. A single couple passing between 5 and 10 amps has a cooling power limited to about ¼ watt, so a number of couples are soldered together and assembled in units (see fig.).

The obvious use of **thermo-electric cooling** for domestic refrigeration is restricted by the capital cost of the equipment which has to compete with the well-established and economic conventional systems. But for instrument cooling the technique has exciting possibilities. Already it has been used in an automatic dew-point hygrometer, a cooled baffle for an oil-diffusion pump, and a thermostat for electronic equipment. Other possibilities that present themselves are temperature control of crystals, air-conditioning of cars—where the apparent disadvantage of D.C. working becomes an advantage—and for cold storage of medical specimens.

The design of control switches for complicated operations has not received, perhaps, the attention it merits, and many machine tools and other equipment employ push-buttons and knobs which require considerable interpretation by the operator. It is refreshing to see that the lessons of the aircraft industry are being applied with the introduction of **joystick control switches.** They consist of a number of conventional switches mounted under a 3½ in. square top plate and operated by a control lever which passes through an oil-filled spherical bearing. The switches can then be arranged so that the operator moves the control lever in the direction in which an operation takes places. Thus the interpretation of the operator is reduced to a minimum with corresponding improvement in speed and certainty of control.

ARTHUR GARRATT

MANUFACTURERS

Master Vision Screener. J. & R. Fleming Ltd, 146 Clerkenwell Road, E.C.1.

360° Counter-Type Indicator. Smiths Aviation Division, Kelvin House, Wembley.

Electronic Gas Detector. IEC Sieger Ltd, 39 Parliament Street, S.W.1.

Thermo-electric Cooling. General Electric Co. Ltd, Kingsway, W.C.2.

Joystick Control Switches. Pye Ltd, Cambridge.

GEOPHYSICS AND SPACE RESEARCH

By ANGELA CROOME

SPACE CALENDAR

NOVEMBER TO JANUARY

3 *Lunik III*'s orbit being distorted by Sun's pull to give it a four-months' life, according to Moscow bulletin.

4 Completion of the first Russian fully steerable paraboloid radio telescope announced. It is 72 ft. in diameter, has a focal length of 31 ft., and is situated at the Lebedev Institute of Physics, Moscow, under the charge of Dr Iosif Shklovsky. Part of its programme will be concerned with the radio emanations from Venus, and the planet's period of rotation may be learnt.

5 *X-15* has near-disaster on third powered flight. Fuel jettisoned at 45,000 ft. after explosion in tail, perhaps due to fuel-leak. Emergency landing successfully accomplished.

10 The five-man executive committee of COSPAR met in Amsterdam to adopt a new formula for the committee's constitution to meet Russian and Australian objections. U.S.S.R. represented for the first time at any COSPAR meeting since March, when these objections tabled. Committee agreed to add a sixth member.

11 First contract for *Dyna Soar*, U.S. Air Force military manned satellite project, placed. It is expected to be launched by a *Titan*, and the first test flights made in three years' time, if sufficient development money is available. Boeing to build the vehicle; the Martin Co. the rocket booster.

12 Four-man WMO panel of weather satellite experts met for first time in Geneva to consider report on this subject by Dr H. Wexler, presented last April. Chairman: Dr G. O. Robinson (U.K.); members: Dr H. Wexler (U.S.A.), Mr W. J. Gibbs (Australia), Prof. V. A. Bugaev (U.S.S.R.), but not present.

12 Jodrell Bank announced that radar echoes off Venus had been successfully obtained during the planet's close approach in September but were fainter than expected. This may have some relation to the surface structure (which is always hidden by cloud). A parametric amplifier was used for the experiment.

15 *Lunik III*'s radio transmissions have ceased, according to a Moscow announcement. Puncture by a meteorite suggested as cause.

16–22 International Rocket Week suggested and co-ordinated by COSPAR. Ten U.S. rockets were scheduled, three British *Skylarks* were postponed due to bad conditions over Woomera.

18 *Snap II*, a five-gallon-size atomic reactor, completed its first run successfully, according to U.S. Atomic Energy Commission. Developed for use in space vehicles and expected to be operational next year. Weighs 220 lb. unshielded; yield, 3 kW; life, five years; fuel, enriched uranium; cost per unit, $400,000.

20 New parachute record established by J. W. Kittinger, of U.S. Air Force, in jumping from 15 miles up, most of it in free fall. He reached this height with a helium balloon. The total descent took 3 min. 40 sec., while the ascent had taken 90 min.

21 1000-ft. diameter space radar project announced by new radiophysics and space research department of Cornell University, U.S.A. It is not known when the radar dish will be completed, but the new professor, Dr Thomas Gold of Cambridge, England, and Cambridge, Mass., takes up his post straight away.

22 Russian Deputy Premier A. Mikoyan declares the U.S.S.R. has a missile able now to reach the Sun.

23 Three distinguished Russian physicists attack Prof. N. Kozyrev of Pulkovo on the irresponsible publication of his theory that time produces energy.

25 Announcement that the new Australian destroyer HMAS *Vendetta* is to monitor *Sputnik III*'s signals during voyages to Asia, by arrangement with CSIRO. This will benefit ionospheric studies. The *Sputnik*'s signals are more clearly received at lower latitudes than in Australia.

26 The most ambitious American lunar probe yet, disintegrated shortly after launching from Cape Canaveral. Launcher was an *Atlas-Able*. The substantial payload (372 lb.) contained a 2-lb. scanning device to monitor the back of the Moon, radiation and magnetic measuring instruments, instrumentation to study solar flares and gaseous clouds of plasma drifting through space. Retro-rockets to be controlled from the Earth were to slow the rocket to enable it to be captured in a Moon orbit.

29 Two American scientists observe Venus through a 16-in. telescope from a balloon 15 miles up. Spectral studies and atmospheric observations were successfully made during a 24-hour flight. Venus's spectrum revealed evidence of water vapour in the planet's atmosphere.

30–DEC. 1 Three *Skylark* rockets fired within 36 hours to observe atmospheric and ionospheric conditions as part of International Rocket Week, programme delayed [16–22 November].

DECEMBER

1 Radio Research Station, Slough, is to devote half its total effort to space research, will build a radio-telescope and be directed from next autumn by J. A. Ratcliffe, C.B.E., F.R.S., who has led the ionospheric research group at the Cavendish Laboratory, Cambridge, with such distinction. Replanning of RRS's research programme is already under way with Ratcliffe assisting.

3 Institute of Strategic Studies' publication states that U.S.S.R. has 100 missile bases, concentrated along the Baltic coast, in the Thuringian Forest of East Germany, the southern Ukraine, and the Carpathians; and 200,000 men in the missile command. Weapons: *T-3* ICBM with a range of 5000 plus; *T-2* and *T-4* IRBMs with 1600- and 1000-mile ranges respectively.

4 Sam, 7-lb. rhesus monkey, successfully tested the escape equipment and capsule of *Project Mercury*, rising to 55 miles in the process.

SPACE CALENDAR—*continued.*

5 The *Vega* satellite-booster programme has been abandoned, to simplify the number of vehicles involved in the U.S. space programme. The rocket, an *Atlas*-based vehicle, had already been designed and was expected to be ready in 1961. This move may release additional *Atlases* for immediate use as NASA space-probes. Effort now being concentrated on *Centaur* and *Atlas-Agena* rockets.

8 A new NASA unit to speed up large space-rocket development is set up under Major-General Ostrander of U.S.A.F., previously deputy director of ARPA. Von Braun is said to approve.

12 Joint resolution calling for international co-operation in the peaceful uses of outer space unanimously adopted by UN political committee and General Assembly. Resolution also calls for 24-nation space committee and an international scientific conference on space research for 1960–1.

30 Australia to co-operate on space research with U.S. on similar terms as Britain. NASA understood to be anxious to include experiment of Dr D. F. Martyn of CSIRO's Upper Air Section in *Scout* satellite. It is designed to monitor long-wave radio waves unable to penetrate the ionosphere. Final version of experiment being prepared for U.S. approval.

JANUARY

1 *Project Ozma*, programme to monitor interstellar sources for artificial signals indicating existence of advanced life, begins at National Radio Observatory, Green Bank, West Virginia.
Prof. H. S. W. Massey, F.R.S., chairman of British space research committee, knighted in New Year honours.

3 In a Russian technical magazine article, geologist Dmitri Scherbakov predicts a rocket that will be fired at the Moon to scrape up some of the lunar surface and bring it back to Earth.

World's Second Largest Radar in Scotland

The second largest radio-telescope dish in the world started working recently on the Aberdeen coast near Fraserburgh. This is an American project, paid for by the U.S. Air Force, but planned, engineered, and operated by the Stanford Research Institute, California, an offshoot of Stanford University and distinguished for daring radio research under contract of a quasi-military nature. The Royal Radar Establishment is understood to be co-operating on some of the experiments.

The telescope's dish is rather more than half as big as the great Jodrell Bank instrument, that is, 142 ft. in diameter as against 250 ft. It is also fully steerable. As with the Jodrell Bank instrument, it can be used as a radar and not only as a receiver. It has a 300 kW transmitter which is more powerful than that at Jodrell Bank.

Another contrast with the British telescope is the speed with which it has been erected. The project was only conceived in September 1958, yet construction was complete by December of 1959. A second to be erected at Stanford is understood to be nearly ready, and there is a third on order for the Air Force Cambridge Research Centre, Lexington, Massachusetts. The cost of the Aberdeenshire instrument is about £70,000.

These radio-telescopes have a novel design. The components are designed in such a way that the superstructure can be brought in by air, in this case from the U.S.A., and put up at a remote site without heavy lifting equipment. To accomplish this, the various struts and cross-pieces that support the 200-ton dish are used during erection as crane-arms and sheer-legs to swing the larger sections up into position. This avoids heavy on-site erection costs. The final result is hardly elegant but very practical.

An ambitious programme of research is planned for this instrument. The prime concern is ostensibly with auroral studies, in particular efforts to bounce radio signals off the aurora. Aberdeenshire is close to the northern auroral zone. The telescope is highly manoeuvrable, turning through 360° in a minute. It may be supposed that the U.S. Air Force is inter-

General view of the radar telescope at Hillhead, Aberdeenshire.

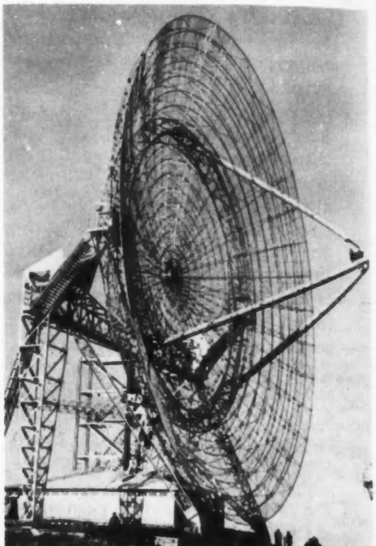


TABLE OF MAN-MADE OBJECTS CURRENTLY IN ORBIT

NAME: *General*	NAME: *Astronomical*	*Up*	*Lifetime*	*Shape and Size*	*Period*	[illegible]
Explorer VI	1959 δ	Aug. 7	? 2 years	Spheroid + 4 vanes 26 in. diameter	12·75 hours	[illegible]
Discoverer V	1959 ϵ	Aug. 13	46 days	Cone-cylinder 19×5 ft.	94·3 mins	[illegible]
Discoverer VI	1959 ζ	Aug. 19	62 days	Cone-cylinder 19×5 ft.	95·5 mins	[illegible]
Vanguard III	1959 η	Sept. 18	100 years	Sphere ended cylinder with "nose", 20-in. sphere 26-in. nose	130 mins	[illegible]
Lunik III	1959 θ	Oct. 4	6 months	Ellipsoid 4·3×3·9 ft.	15 days 11 hours 40 mins	[illegible]
Explorer VII	1959 ι1	Oct. 13	10 years	Double cone 30×30 in.	101·5 mins	[illegible]
Explorer VII Rocket	1959 ι2	Oct. 13	5 years	Cylinder	101·3 mins	[illegible]
Discoverer VII	1959 κ	Nov. 7	19 days	Cone-cylinder 19×5 ft.	95 mins	[illegible]
Discoverer VIII	1959 λ	Nov. 20	3 months	Cone-cylinder 19×5 ft.	104 mins	[illegible]

ested in other things beside auroral particles that move fast across the sky at high latitudes. The radar has a classified research programme in addition to its published basic research projects.

Tests are also to be carried out on unorthodox long-distance communication methods such as bouncing signals across the Atlantic off Earth satellites and via the Moon. It will probably take part in *Project Tiros*, the passive communications satellite programme due to be launched soon. Another idea that both the American Air Force and Stanford are interested in is the possibility of using artificially produced chemical "clouds" at up to several hundred miles high as radio reflectors. In the *Smoke-puff* series of rocket firings carried out in 1956, Stanford scientists succeeded in making radio contact via an artificially produced sodium cloud in this way.

Russians Reach the South Pole

The Russian tractor-train reached the American base at the South Pole early in the morning of Boxing Day having been three months in the field. The South Pole is 1676 miles from Mirny. This is the first time the South Pole has been reached from the Indian Ocean side, and only the fourth occasion on which it has been reached at all, overland. Three Kharkovchanta snow-tractors led out the expedition from Komsomolskaya at the beginning of November; only two arrived at the Pole. After some days rest and research at the Pole the Russian team returned on their tracks towards Vostok. There were sixteen men in the party that reached the Pole led by Alexander Dralkin, chief of the fourth Soviet Antarctic expedition.

During the journey to the Pole the expedition had been working a 17- to 19-hour working day, with only two two-hour halts for meals. The scientists slept in the caravan-like Kharkovchankas on the march and the drivers slept while the scientists were making their measurements at the halts. These occurred at roughly 100 km. intervals and often lasted many hours while seismic observations were taken and snow-pits dug to obtain snow temperature measurements at different depths, and other observations made. For much of the way the expedition appeared to be travelling on a plateau which at times rose to a height of 9800 ft. Temperatures remained below zero and sometimes dipped as low as −60°C. Patches of loose drift snow caused the party the most trouble. The heavy tractors sank deeply into these. Tracks had to be changed or repaired frequently.

The principal Russian expedition ship, the *Ob*, relieved the new Russian station of Lazarev on the Atlantic coast, on December 19. She called there before steaming east to Mirny with the main party of the fifth expedition. Ice conditions are again rather bad this year and the *Ob* had to negotiate eighty miles of tough pack to reach the Queen Astrid coast.

Two Other Expeditions Stuck

The year ended with both the Belgian and the South African expeditions held up in the ice some distance from their destinations; the Japanese were understood to be similarly immobilised. A 100-mile-an-hour blizzard struck Mawson at this time, wrecking both aircraft and doing immense damage otherwise.

More Swiss Glaciers Receding

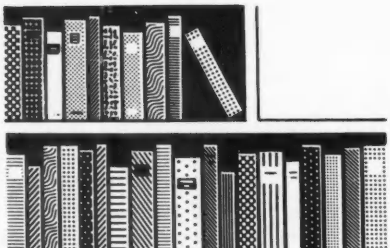
The report of the Swiss Glacier Commission for 1957–8 indicates that due to an unusually dry season the expected halt to the general glacier recession did not occur and indeed the shrinkage during the period under review was greater than in the year before.

Eighty-three out of a total of eighty-nine glaciers receded during 1957–8; whereas three were stationary the year before none was stationary, and only six were advancing as against ten. The average decrease in length in the period was 48 ft. as against 30 ft. in 1956–7. The six glaciers advancing despite the general trend were: the Allalin, the Bella Tola, the Martinets, Prapio paneyrosse, and Damma.

The forecast for the present year is even more discouraging as a result of the long hot summer of 1959.

			RADIO		
Weight	*Instrumentation*	*Principal Scientific Value*	*Characteristics*	*Radio Lifetime*	*Other Points*
142 lb.	High-, medium-, low-energy radiation experiments and magnetic field measurements; "Whistler" radio experiment; cloud-cover scanner; micro-meteorite microphones	Detailed cross-section of radiation surrounding the Earth	UHF transmitter digitalised memory 108·06 Mc/s Ion-power telemetry 108·09 Mc/s Ion-power telemetry LF transponder receiver, HF receiver	Stopped prematurely perhaps because one "paddle" did not open properly	All radio equipment served by 8000 solar cells. Telemetry in triplicate (for "Whistler" experiment.) This is able to command 30 switches including radio master-switch
1700 lb.	Nuclear emulsions; recovery equipment	Attempt at recovery from space (failed)	Not released	—	—
1700 lb.	Nuclear emulsions; recovery equipment	Attempt at recovery from space (failed)	Not released	—	—
100 lb. payload 50 lb.	Magnetic measurements. Solar x-rays produced by solar flares; various temperature and micro-meteorite measurements	Solar flare observations	108·00 Mc/s transmitting continuously 108·03 Mc/s telemetry on command	3 months	—
614 lb.	TV camera; magnetic and environmental measurements	Photography of back of Moon	Disclosed transmitters: 29·986 Mc/s 183·6 Mc/s Receiver(s) also carried	About 3 weeks	Radio powered by both solar and chemical batteries. Data accumulated and relayed at periods previously announced
91 lb.	Van Allen and cosmic radiation measurements; Earth's heat-balance; micro-meteorites; x-rays	Earth's heat-balance	108·03 Mc/s telemetry on command 20 Mc/s	1 year by built-in switch	Solar charged chemical batteries
—	—	—	—	—	—
1700 lb.	Nuclear emulsions; recovery equipment	Attempt at recovery from space (failed)	Not released	—	—
1700 lb.	Nuclear emulsions; recovery equipment	Attempt at recovery from space (failed)	Not released	—	—

THE BOOKSHELF



New Basic Training Methods in Electricity and Electronics

Basic Electricity
(*Technical Press Ltd, in five parts, each about 130 pp., 12s. 6d. per part or 55s. complete*)

The "Trainer-Tester" in Electronics
(*Set EL53*). *No price given*

During the last twelve months there has been a considerable influx from America of ready-made teaching material in the electrical and electronics field, supposedly enabling students of all degrees of knowledge to teach themselves the subjects under review. The basic approach is that of the correspondence course.

In Britain the aim of the majority of students of electrical subjects is to gain a qualification which will enable them to apply for a post in a large firm or corporation, and without which their future chances will be considerably jeopardised. More and more, the bodies who grant diplomas and degrees stringently insist on the proper marriage of theory and practice, and almost certainly none of them will accept as a qualified member a student, however painstaking he may have been, one who has acquired his knowledge solely from a correspondence course. This is not to say, of course, that such courses do not have a value in particular circumstances; but the American attitude to this matter, as revealed to the present reviewer in several recent conversations with American engineers, is fundamentally different from that adopted in Britain and, indeed, in most of Europe.

If it is desired to teach the bare rudiments of electricity to students possessing very little mathematical or, indeed, general knowledge of any kind, the "Course in Basic Electricity" could scarcely be bettered, although it must always be realised that it can never be regarded as any sort of substitute for the combination of personal teaching and practical experience which nowadays forms the essential background to the training of every apprentice in Britain who desires to progress to positions of higher responsibility.

The course was developed for the U.S. Navy by a firm of Management Consultants and Graphiological Engineers, Messrs Van Valkenburgh, Nooger, and Neville, Inc., and has been revised by REME to suit British conditions. The approach is almost entirely non-mathematical, and thus the writers introduce perhaps an unnecessary rod for their own backs. It is not unreasonable to expect anyone who enters on a course of this kind to have the simple tools of elementary geometry, arithmetic, and algebra. The illustrations are much lauded by the publishers, but as many of them are of the cartoon type they tend to distract rather than assist the reader. Over-simplification has led in several cases to errors; for example, on page 325 in showing how to measure the secondary voltage of a transformer the primary appears to be supplied by means of a single wire.

The text is very well written indeed, but again over-simplification sometimes defeats its own ends and it is necessary to read a paragraph three or four times before its meaning is clear. The terminology is not above criticism; for example, in dealing with "How Magnetism Produces Electricity" one reads "The source of electricity must be able to maintain a large charge because the charge is being used to furnish electric power". "Charge" would not be the word commonly used in this connexion, and could be misleading. The illustration on this page (130) seems largely meaningless.

Nevertheless, there are readers for whom this course will provide the help they need; as long as they are warned that it will not assist them in becoming qualified technicians, unless they combine it with theoretical and practical training on the lines required by the bodies giving qualifications. It is only fair to say that the publishers make it clear that the purpose is limited to the training of technicians not of engineers. "The manual's aim is to turn out men capable of operating, maintaining, and carrying out routine repairs to the equipment described—not men capable of inventing or improving it."

The same originators, Van Valkenburgh, Nooger, and Neville, Inc., are responsible for the "Trainer-Tester". Technical Designs Ltd, are licensed in Great Britain to produce these devices. A typical set concerns the fault diagnosing of a superheterodyne receiver.

The method adopted here is to provide sheets of paper about 10½ in. high by about 16 in. wide which are used to instruct students in fault diagnosis. The first sheet gives "step by step" instructions and the second and third sheets provide, respectively, a photograph of the underside of a typical superheterodyne receiver and a wiring diagram.

The fault diagnosis sheets contain a large number of data columns, for instance a column in which the student selects a test point on the receiver to which he is supposed to have applied a meter to read the conditions obtaining at that point with respect to the chassis. The columns for the readings so obtained are obscured by a special ink which can be rubbed away with an ordinary india-rubber, disclosing the values which would have been obtained if the actual operation had been carried out. Each fault sheet contains a list of symptoms which the receiver is supposed to exhibit, and as the student thinks out how he would proceed with his testing, he rubs out the obscuring ink and numbers the steps he has taken. Thus the instructor can ascertain what tests he made, and in what order. When he finally lights on the scene of the defect, he then decides which component to replace, and that answer, when applied by the "rubbing out" process to the sheet, discloses the information (if it is the correct solution) that the fault has been cleared.

One must pay a considerable tribute to the ingenuity of the designers, but one is inevitably led to the thought that few of us would travel, for example, in an aeroplane whose pilot had learned to fly by reading it all out of a book. In this field, as in every branch of engineering, there can be no substitute for practical work carried out under the supervision of an experienced teacher. The superheterodyne receiver in the diagrams on this "Trainer-Tester" set is no doubt a perfectly good example of a particular circuit arrangement; but nowadays with the evolution of printed circuits, miniaturised components, transistors, and the like, the difference between manufacturers' approach to any circuitry is so wide that the unfortunate student used to the simple open layout adopted for teaching purposes on these sheets would soon become irretrievably lost.

Once again the enormous difference in outlook between the American educationists and the British is apparent in the thought behind these ingenious devices. Discussion with a radio service engineer of considerable experience indicated that any apprentice working for him is discouraged from endeavouring to teach

himself. He prefers his young men to get a basic grasp of first principles at a Technical college, while they are carrying out simple practical work in the service shops during the day. The combination of guidance in pursuing the theory and guidance in applying it practically seems to him the only possible way that any useful training could be achieved.

However, the pressing need for technicians in Great Britain may lead us to revise our ideas, and we should be very unwise to neglect such aids as these without the most careful scrutiny as to their practical application. We have not, in the past, wished to train "rule of thumb" engineers who can only repeat, parrot fashion, the facts they have learned without reference to how these facts were arrived at. But perhaps we could be wrong.

J. H. M. SYKES

Fifth Report from the Select Committee on Estimates. Session 1958–9. United Kingdom Atomic Energy Authority (Production Group and Development and Engineering Group) (*H.M.S.O. 5s.*)

Although the Atomic Energy Authority gives an account of the major developments within its Industrial Group in its annual report to Parliament, the significance of the Select Committee's study lies in the simple fact that the work of the Authority has not previously been examined in such scope and detail by any Parliamentary Committee. The Committee's examination is far more than a routine check to ensure the absence of extravagance or lax administration. It has sought to assess whether the ways in which policies are being executed and the organisation of the Industrial Group are obtaining the best return for the money invested in this new field of scientific endeavour, but it has also indicated its views as to methods by which the Authority could carry out changing responsibilities in the future, and certain specific recommendations have been made.

In the main, the Committee gives the Authority a clean bill of health, and pays tribute to its organisation in a rapidly changing field. Bearing in mind the novel problems encountered, the Industrial Group has shown an appropriate degree of cost-consciousness and a readiness to make further adaptations in procedure. Inadequate control, however, at Dounreay cost £500,000. More significant though than its observations on financial control are the Committee's comments on the general strategy of nuclear developments in the United Kingdom, and on the relations between the Atomic Energy Authority and industry. As to the former, the Committee shows a fair-minded approach to trends in the economics of nuclear power, but it stresses the importance of a greater concentration on the fast reactor if satisfactory progress is to be sustained. As to the latter it emphasises the increasingly greater concentration on civilian work, and stresses the importance of close contact between the Authority and industry at all stages. There is an undoubted danger of under-employment in the nuclear engineering industry, while at the same time the Authority acquires still more work without the possibility of a corresponding growth in skilled man-power. Clearly the solution of such problems will be of immense importance to Britain's scientific, industrial, and economic future. The Committee, in evaluating some of the principal issues involved for our legislators and for the public has, whatever the validity of its many findings and criticisms, performed a valuable act of national education.

The Concise Dictionary of Science
By Frank Gaynor (*Peter Owen, London, 1959, 546 pp., 50s.*)

The story is told of a storekeeper employed by Chambers, the Edinburgh

publishers, who used to read each one of his firm's books as it came through his hands. One day a director of the company asked him his opinion of a consignment of a new book sent in from the printers for despatch. "There's plenty in it," said the old man, "but it's a wee bitty disjointed." The volume in question was a dictionary.

In his preface to Mr Gaynor's work, William Laurence of the *New York Times* points out the remarkable changes which science has exerted on our lives during the last quarter of a century. He refers to the advent of the Atomic Age, to "earth-circling" satellites, "life-saving" antibiotics, virology, enzymology, and cytogenetics. And he also draws attention to the importance of people being able to understand what is happening even though it is described, as it often must be, in specialised scientific terminology. This problem of understanding may be as baffling for men and women in different compartments of science as it is for non-scientists. For this reason it is disappointing to find that in spite of the title on the spine and the encouraging preface, this is not a concise dictionary of *science* but only a dictionary of words used in certain of the non-biological sciences. These are, in fact, listed inside the fly-leaf as physics, mathematics, nucleonics, astronomy, and chemistry. Biological terms are almost comletely absent—no "penicillin" or "streptomycin", although "antibiotic" is there; no "gene" or "chromosome", although "protein" and "enzyme" and "hormone" are duly listed. "Plasma", as might be expected, is defined as "electrified gas", "cell" appears as "see *electric cell*" and "nucleus" is "the central core of the atom". There are one or two surprises of a different character. For example, although a "calorimeter" measures heat, a "coolometer" measures cooling, while "hot" to a scientific dictionary can, of course, only mean "highly radioactive". "Glucose" and "fructose" appear in their appropriate places, but not "maltose". A few of the words show signs of transantlantic ancestry. For instance, I am not sure whether "chempure", "electronate" (meaning in chemical terms *to reduce*), "ox", or "slug" would gain admittance to a British lexicographical Who's Who.

This book contains a great deal of useful information. Its definitions are short, as it was the author's intention they should be, and would seem substantially accurate. Having been given much, it were ungracious to ask for more, but a concise dictionary of *science* would have been better still. As it is, the old storekeeper at Chambers still has the last word.

M. PYKE

Proceedings of the 9th International Astronautical Congress

Edited by F. Hecht (*Springer-Verlag, 1959; vol. 1, 506 pp.; vol. 2, 464 pp.; £17 13s. 6d.*)

These two substantial volumes contain no fewer than seventy-four papers on various aspects of astronautics written by ninety-three contributors from twelve different countries. As might be expected, American papers predominate, and a total of fifty-two papers are written in English. The remaining contributions are in French, German, and Russian. Of the three Russian papers, two are printed in English, but all papers have short summaries in English, French, and German. Three papers were presented from the United Kingdom.

These volumes contain a mine of information, ranging from topics such as the "Immediate Feasibility of Orbiting an Astronomical Telescope" by Prof. Whipple, to "Relativity and Astronautics" by Dr F. Cap. More than half the papers are concerned with propulsion in one form or another, with studies of artificial satellites and general engineering and structural problems running second. Orbits are given some detailed consideration, and astrobiology also comes in for attention. There are only five papers which one could class as general review papers, and two only are concerned with upper atmosphere research. The main emphasis, as at all previous Congresses, is on original research, and the volumes abound in studies of this sort. Accordingly, they do not make for easy reading, though some of the papers are outstanding in their clarity and deserve to reach a wider audience than will be possible in the present volumes.

The field covered by the papers is so wide that only a few of particular interest to your reviewer can be mentioned. Dr von Braun has contributed a detailed appraisal of the *Explorer* satellites and their carrier vehicles, though one might have wished him to deal instead with the engineering of massive space-vehicles associated, for example, with project *Saturn*. Prof. Ogornodnikov describes the impressive Soviet organisation for optical observation of artificial satellites, and very comprehensive it is, too, with teams exceeding a total of 3000 observers. This compares with the 100 Moonwatch observers in three teams organised in this country by the British Interplanetary Society to date.

There are several papers on future methods of propulsion. Dr Theodore von Karmán provides "Magnetohydrodynamics—a General Review", while Dr L. R. Shepherd, BIS chairman, presents "Electrical Propulsion Systems for Spaceflight", in which he suggests that, for

relatively low specific impulses of 10,000 sec. or less, a magnetic accelerator which accelerates a neutral plasma may be superior to the conventional accelerator in which separated positive ions are accelerated in an electrostatic field. He also envisages the possibility of using a plasma generator coupled to a magnetic accelerator, using sodium as a propellant. Considerable thought seems to have been given to novel methods of propulsion since these papers were presented, as evidenced at the recent 10th IAF Congress in London, when papers on this subject predominated.

Dr von Beckh provides a paper on human reactions to acceleration followed or preceded by weightlessness, based on flight experiments in jet aircraft. The occupants were subjected to 6·5 g for periods of up to one minute, producing in several cases a marked "black-out". The original paper, when presented, was followed by a film of the work carried out, frames from which have been used to illustrate the paper.

Heinz Koelle appears to have undertaken something of a marathon in his "Classification of Orbital Carriers and Satellite Vehicles", based on studies of nearly 1000 unclassified references. Nine different types of orbital carriers, twelve different types of satellite vehicles, and seven typical return-and-recovery schemes are defined and explained in three tables, plus a comprehensive bibliography. R. P. Havilland goes farther afield with "Considerations of a Solar Probe", which considers the problems of propulsion, thermal design, component temperature limits, attitude stabilisation, and telemetry, together with a selection of potential probe experiments.

The volumes are handsomely produced but rather expensive. Some alleviation is contained in the publishers' announcement that a 20% reduction in price is given to members of the IAF Member-Societies, but even so, the cost is high. The above volumes reproduce only the technical proceedings of the Amsterdam Congress. The papers presented at the Space Law Colloquium held at The Hague appear in a separate volume. L. J. CARTER

Brief Note

The Ministry of Agriculture, Fisheries and Food has released its catalogue of books on Agriculture and Horticulture (Bulletin 78, H.M.S.O., *5s. 6d.*). It contains a list of the popular and semi-popular works added to the library during the war and the immediate post-war period. These works had been omitted from the previous bulletin because of insufficient space. A large number of technical work and research monographs issued since 1954 have also been included

The Sea Bed

By V. Zenkovich (*Lawrence & Wishart, 1959, 61 pp., 3s.*)

The author of this little book (printed in Russia) is well known for his work on shore dynamics and marine sedimentology, but it is not obvious to what class of reader this English translation is addressed. Much better introductions to the geology and morphology of the sea floor were already available in English and French. Though the English text "flows" reasonably well, there are signs that the translator lacked technical knowledge. Thus, we read of radiolarian tests being of silicon, and the deep Atlantic currents being mainly "ebb and tide" to cite only two such signs. There are also some surprising mis-spellings in this slim volume whose chief value to English readers will lie in what it tells about certain Russian research trends and instruments especially in respect of sea-floor coring.

Alongside a two-piece sketch of a plummet with detachable weight which differs hardly at all from the figure long associated with the name of Brooke, we read that the device was invented by Czar Peter I who was the first to measure depths exceeding 1000 m.

J. N. CARRUTHERS

Schweizer Pioniere der Wirtschaft und Technik (*in German*)

8. Walter Wyssling, Albert Wander (both by Hans Rudolf Schmidt), Henri Cornaz (by Aymon de Mestral and Rudolf Keller), 72 pp.

Pionniers Suisses de l'Economie et de la Technique (*in French*)

4. Jean-Jacques Mercier-Marcel, Gustave Naville-Neher, René Thury, Maurice Guigoz (by Aymon de Mestral), 88 pp.

(Zürich: Verein für wirtschaftshistorische Studien, 1958. Swiss fr. 6 each.)

Some of the earlier numbers of this series were reviewed in DISCOVERY, 1957, vol. 18, No. 8. These are also brief character sketches of scientists, engineers, and *entrepreneurs* who made notable technological innovations in Swiss industry, with some account of their main achievements, good illustrations, and bibliographies for further reading.

The present pair, however, are less interesting than the early numbers (one of the best of which, on Daniel Jean-Richard, is now available in English). Those early numbers which covered only one pioneer in a volume gave a vivid impression of their subjects, with enough detail to explain the technical and economic significance of what they did, even though their side-interests were barely catalogued, and little was said about the social and economic background of their work, but where three or four pioneers are covered in one volume, the effect is rather like an extended obituary notice in *The Times*. A short section gives a vivid but highly superficial sketch of the man, and the rest catalogues what he did. The implications of his successes, and especially of the difficulties he had to overcome, have to be deduced, or even guessed.

From the title of the publishers, one would hope that they were making a serious attempt to throw light on the factors that affect industrial progress, and especially innovation; but the biographies, and the apparent absence of other publications, suggest that they are more concerned to produce propaganda in favour of highly individualistic lone workers (after the manner of the "research" department of a political party). They are missing a great opportunity. From their bibliographies, they clearly have access to a great deal of useful and interesting source material. Edwards and Townsend, in their fascinating "Business Enterprise" (Macmillan, 1958), have shown how a collection of brief thumbnail sketches can be worked over to give valuable insights into the economic, social, and personal factors that interact in the growth of a business or spread of an innovation. Could not the Verein für wirtschaftshistorische Studien attempt to combine and compare the accounts of their heroes so that here, also, some sort of general picture might emerge? Alternatively, they could well expand some of the recent short biographies into something longer. I would especially like to see a full-dress biography of Henri Cornaz, the peasant from Waadtland. Why did he think it would be a good thing to run a cement factory as a sideline to his farm? What were his relations with his technical experts, especially when he switched over to glass-making, about which he appears to have known no more than that he had a supply of suitable sand? What were the family relationships of a man who "would rather give a hundred francs to a poor chap, than five to his children for a treat"? The bare bones of his story suggest a fascinating living body.

T. E. EASTERFIELD

Some Outstanding Clocks over Seven Hundred Years

By H. Alan Lloyd (*London, Leonard Hill (Books) Ltd, 1958, 152 pp., illustrated, 70s.*)

This fine book can be unreservedly recommended to all interested in clocks and constitutes a "must" to all who are interested in horological development. Indeed, it is difficult, in dealing with this book, to refrain from using too many superlatives lest they become meaningless.

The author is a well known antiquarian horologist and writer, and the book is distinguished by being almost entirely new and not merely a repetition of what has been written before.

Reading it, one will find only passing mention of such well known and honoured names as Tompion, Graham, Arnold, and others. On the other hand there will be found full descriptions of the amazing products of such early workers as de Dondi, Harbrecht, Baldewin, and Burgi. Also dealt with in detail are clocks by such makers as Williamson, Watson, Bridges, and Radeloff.

One cannot help being astonished that these early workers had such a command over their materials, as well as over every branch of their craft, that they produced clocks of such beauty and complexity as are described here. To take Baldewin's Planetary Clock, for example, to construct such a clock today would require the resources of a very well equipped workshop. The early makers seem to have thought nothing of cutting gear-wheels with very many teeth and of the oddest number. One of de Dondi's wheels had no fewer than 365 teeth. Baldewin even used a wheel with 547 teeth and, somewhat later, Facini embodied in his famous clock a ring-shaped wheel having 238 internally cut teeth and 280 external teeth.

To deal with clock development over 700 years is no easy task, and the author is to be congratulated in producing such an absorbing volume.

While early work is dealt with so fully, it seems a pity that more modern developments are dismissed somewhat cursorily. For example, Jens Olsen's great calendar clock at Copenhagen, built during the period 1944–55, is scarcely mentioned, although it is undoubtedly the most extraordinary clock built this century.

If one may be permitted a word of criticism, the words *concoid drive* (Plate 41) seem incorrect. There is no reference to this kind of drive in the glossary of the book under review and the only reference in the index is to another page. The word *concoid* does not appear in the *Oxford English Dictionary*, nor is it given in any of the reference books that the reviewer has consulted. It may be that the word should be *conchoid*, indicating a spiral, but in this case it would be preferable to use the words *helix* or *helical* as being less esoteric.

While the reader is unlikely to find a clock for sale of the age and complexity of the majority of clocks described here, it cannot be denied that the million-to-one chance does still exist. The romance of clock-collecting is very well illustrated by the find of Dr V. Bertele of a clock by Nicholas Radeloff (*c.* 1654) in a junk-shop at Caterham.

Needless to say, this book is excellently produced, superbly illustrated, and should provide the reader with many hours of fascinating reading. If it does this, the cost of the book is indeed not excessive.

R. MC. V. WESTON

Department of Scientific and Industrial Research and Fire Offices' Committee: Fire Research 1958. (*H.M.S.O.* 5*s.*)

This Report of the Director on the work of the Fire Research Station, introduced by the Report of the Fire Research Board to the Council of Scientific and Industrial Research and the Fire Offices' Committee, is of a wide as well as specialised interest. It contains not only an account of the detailed problems which are the subject of investigation and essential basic statistics on the incidence of fires, but also information on the cause of certain fires in the home which might seem to conflict with popular preconceptions. While the number of fires in homes remains steady, if not actually declining, there are important changes as to the cause of such fires. Not only is the wider use of electricity and oil leading to a corresponding increase in the number of fires resulting therefrom, but evidence shows that the risk of starting a fire when using coal to produce a given quantity of heat is only one-third of that when kerosene is used; moreover on this basis the fire hazard from electricity appears to be far greater than that of any other fuel. Given current trends in domestic fuel appliances, the fullest research into effective preventive measures is necessary if there is not to be a major increase in the number of fires in homes.

It is in this context that the work of the Fire Research Station should be appreciated. Special attention *inter alia* has been paid to the use of models to study fires in buildings so that structures can be designed which both minimise the spread of fires and withstand fire conditions. A second area of investigation was into the control and extinction of fully developed fires in rooms, which provided a striking indication of the small amount of water required for this purpose. More radically, the use of turbo-jet engines to extinguish fires in large buildings is under examination.

This is an encouraging Report. The fact that more inquiries are coming to the Station and that more of these require practical tests is gratifying, even though these may at first deflect from the volume of research that can be done. However, the highly operational character of the Station's research programme reinforced by its sponsorship of fundamental research in the Universities suggests that knowledge about fires and countermeasures is likely to grow.

SCIENCE ON THE SCREEN

High-Speed Flight—A Film Trilogy

The Shell Film Unit has produced a high-level series of three films to explain something of the aerodynamic theory of high-speed flight. The first part deals with the problems of flight just below the speed of sound. The second deals with transonic speeds, when the aircraft is moving round about the speed of sound. The third part shows the behaviour when aircraft are travelling well above the speed of sound.

Technique breeds technique, and research breeds research. The film unit was faced with the problem of showing the effect of air-flow over wing sections and aircraft models in wind tunnels. They used colour Schlieren cinematography. This is a technique which makes differences in air density visible to the camera. Black-and-white Schlieren photography has been known for many years. The National Physical Laboratory invented a technique for producing colour Schlieren. The Shell Film Unit developed this method for 35 mm. film camera work.

They considered this process so interesting that they made a film, "Schlieren", to explain the process.

The "High-Speed Flight" series continues the older six films, "How an Aeroplane Flies". These dealt with flight at speeds at which the air acts as if it were incompressible.

Shell intend these films to be seen by airline pilots who are transferring to jets. It is thought that it will be a useful training film for other members of airline staffs, air forces, air cadets, students and, in fact, all air-minded people. Your reviewer is slightly less optimistic about the general use of these films, as a high initial scientific background is desirable, if this rather fast and complex technique of exposition is to be understood clearly. Shell state that this film is already part of the normal training of NATO air forces.

Schlieren

35 mm. and 16 mm. colour, sound, running time 18 minutes. Produced by the Shell Film Unit; director, Peter de Normanville; photography, Ronald Whitehouse; animation, Peter Arthy. Available on free loan to education establishments, museums, service units and other responsible organisations or clubs. It may also be borrowed by individual firms. It may not, however, be shown to audiences who pay for admission.

This film describes a recording technique clearly and relatively simply. It uses actual shots, animated diagram and mock-ups to demonstrate the Schlieren process.

Schlieren, which is the German word for internal streaks or striation in glass, was originally developed by German glass manufacturers for discovering faults in their manufacturing processes. It was first developed about a hundred years ago. A simple way of testing glass is to stretch parallel wires on a frame. The wires are distorted when there are faults in the glass because of changes in the refractive index. The way in which a light source and concave mirrors and coloured filters can be used to produce a coloured Schlieren effect is demonstrated. The choice of colour is entirely arbitrary. Red is used to show greater density of air. Green, where the pressure is normal; and blue, areas of decreased air density.

The combination of actual Schlieren cinematography, animated diagram and the build-up of the actual production set-up makes the process extremely clear and simple. To change the tempo from the naturally rather severe, scientific approach, the fact that Schlieren can be used to photograph a silhouette is shown by a hand-shadowgraph of a dog which barks on the sound-track. This has shock impact, makes the audience smile gently and therefore relaxes the tension. This is a good teaching technique.

The sensitivity of the Schlieren process is demonstrated by showing the movements of air warmed by a hand, and cooled by an ice-cream while it was being eaten. The problem was also related to everyday life by photographing the movement of air above an electric stove close to the wall, to demonstrate why it caused a dirty patch.

The film then shows how air movement over an aerofoil section spanning the whole of a wind tunnel is recorded at different air speeds. We see the building up of shock waves. This photography is possible because light travels a little more slowly in the dense air behind the shock waves.

In the changing colour shapes there is a Disneyesque quality—a strange form of beauty. This whole film is fascinating and exciting, because it shows intelligently and sensitively how new developments in one field—aerodynamics—triggers off developments in another—cinematography.

The film ends with demonstrations of other uses of Schlieren. Showing how all kinds of heating and ventilation problems can be studied by this process. Gas leaks can be discovered. Flame can be observed. The dissolving of substances in liquid, the behaviour of sprays and the effect of pouring one clear liquid into another becomes visible. The combination of Schlieren photography with high-speed cinematography can allow the behaviour of the sparking plug to be observed. The mixture of fluids at different temperatures can be studied. In fact, like most techniques developed for a specific purpose, there are a very large number of unsuspected applications.

This is a most interesting film and it could, with advantage, be used in schools as well as for cinetechnicians.

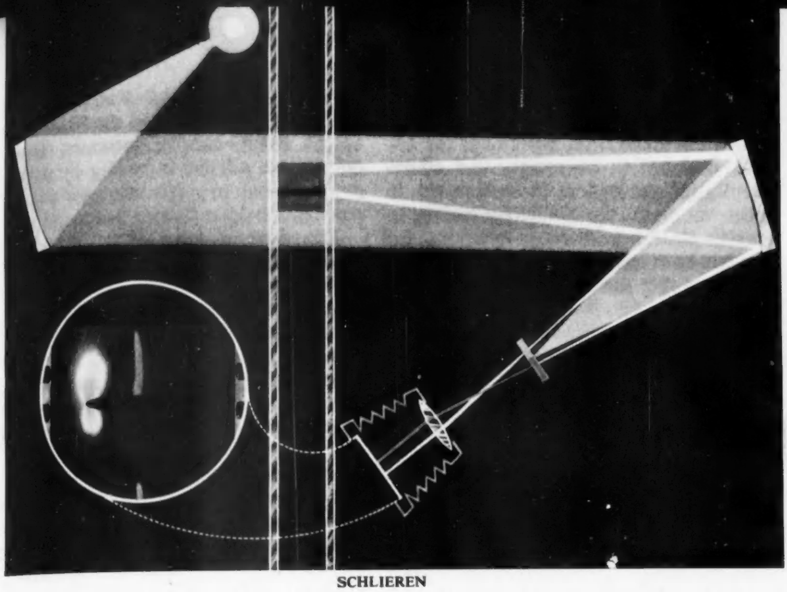
High-Speed Flight. Part 1: Approaching the Speed of Sound

35 mm. and 16 mm., colour, sound, running time 28 minutes. Produced by the Shell Film Unit. Director, Peter de Normanville; photography, Sydney Beadle; animation, Francis Rodker, Archie Shaw, Leslie Davie. Air Ministry technical adviser, Squadron Leader J. N. Quick, M.A., A.F.R.AE.S., RAF Production consultants, Film Centre. Available on free loan to education establishments, museums, service units and other responsible organisations or clubs. It may also be borrowed by individual firms. It may not, however, be shown to audiences who pay for admission.

This film sets its own atmosphere. We see a strange cloudscape with the sound of a high-speed jet engine. The titles come in, then we see a series of aircraft designed to approach the speed of sound. These air-to-air views of modern aircraft immediately show the vast advance from Wright and Blériot. Then the film returns quite simply to explain how sound travels through air. Clear, simple shots of tuning forks and spiral springs demonstrate how air is alternately compressed and rarefied. A stone dropped into water leads to animated diagrams explaining how sound goes out from its source. Quite simply and progressively a combination of actuality and diagram demonstrates the speed of sound and how this changes with temperature; and temperature falls with altitude.

The demonstration continues to show what happens as the point emitting sound speeds up to the speed of sound. At this speed the sound pressure waves cannot travel out ahead of it, for the point is travelling as fast as they are.

The Mach number is defined as the ratio of an aircraft's true air speed to the speed of sound where it is flying. The method of calculating the Mach number is demonstrated very clearly by diagram.



SCHLIEREN

A diagrammatic view in plan of the process of Schlieren photography. A lamp (*top*) projects a beam of light on to a concave mirror (*top left*), which reflects it transversely across a wind-tunnel (*centre, top to bottom*) to another concave mirror (*right*), and from thence, via coloured filters, to the camera (*bottom*). The bright minor beams represent light-rays which produce the special pressure effects seen on the enlarged film frame (*bottom left*).

(By courtesy of Shell Film Unit)

The relationship of Mach numbers to wing design is shown and Schlieren cinematography shows how shock waves form on the wings and gives a general picture of areas of high and low pressure.

This section of the film is fascinating, but rather fast moving and when your reviewer tried to reconstruct the film in his mind he found it difficult, though the notes he had taken allowed him to make a fairly full reconstruction. If there is a criticism to be made of this film it is that it is too crammed with information. Possibly the definition of the problem and the meaning of terms, such as Mach number and the basic information about sound, could have been a separate film. In this way there could have been an introduction to high-speed flight before daring to approach the speed of sound.

The use of smoke in the wind tunnel adds force and clarity to the Schlieren photography and the diagrams. Unfortunately film is not ideal for giving definitions of slight variations. There are a number of Mach numbers which are defined one after another and sentences in the commentary such as "The Mach number here will always be greater than that of the aircraft as a whole—called the flight Mach number. As the flight Mach number increases so does the local Mach number at the maximum speed-up point." A little later we hear of the critical Mach number. These are visually demonstrated on the screen, and if the tempo was a little slower there would be more chance of the point being remembered. On the other hand if the audience is prepared by prior reading, or a talk, or if the film is followed by discussion, the teaching result should be achieved. A series of filmstrips or slides might be useful to allow a more detailed and slower study of these rather complex problems.

The behaviour of aircraft above the critical Mach number is shown. There are cases of violent instability. We see how and why problems arise when approaching the speed of sound, this leads to a demonstration of how high-speed aircraft are designed. A short explanation of the Schlieren technique is inserted. This is a mistake. This film is already sufficiently complex without introducing a red herring, however interesting.

The film continues using actual shots, Schlieren, and different kinds of diagram to show problems and their solution in relation to different designs and wing shapes. The effect of air-flow on straight wings and swept-back wings is demonstrated, and the film concludes with a review of various types of modern aircraft. We see delta shapes, sweep back, thin wings, crescent wings—almost every type, except the flying saucer. One realises the compromise between low speeds, high, speeds, and those which surpass sound.

Sound is used most excitingly. On the whole the choice of words is simple, except where it is essential to use technical terms. The voice of the commentator is clear and reasonably slow. The visuals besides explaining the theme are attractive to the eye. There is a danger, however, of severe mental indigestion, unless the film is integrated with an introduction based on the intellectual and educational level of the audience.

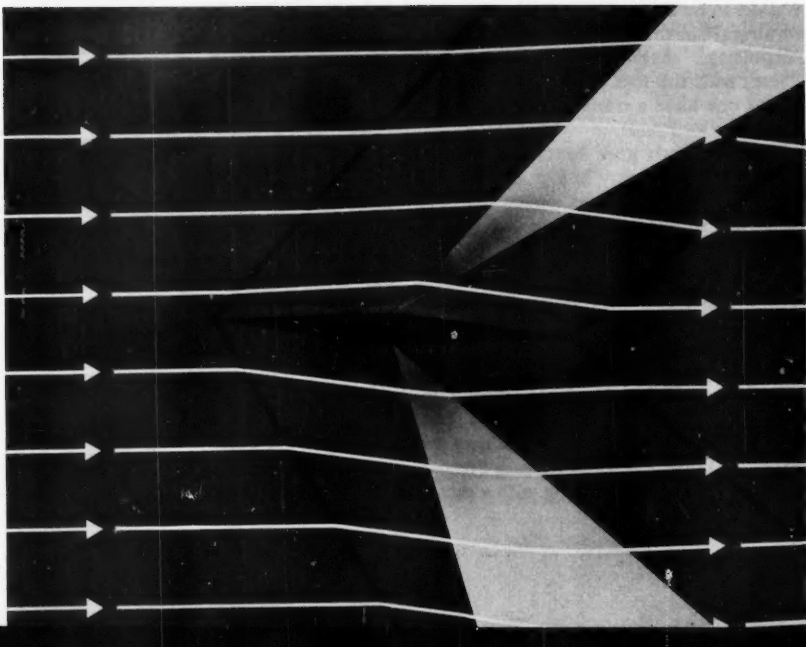
High-Speed Flight. Part 2: Transonic Flight

35 mm. and 16 mm., colour, sound, running time 23 minutes. Produced by the Shell Film Unit. Director, Dennis Segaller; photography, Sydney Beadle and Ronald Whitehouse; animation, Francis Rodker, Archie Shaw, Leslie Davie. Air Ministry technical adviser, Squadron Leader J. N. Quick, M.A., A.F.R.AE.S., RAF. Available on free loan to education establishments, museums, service units and other responsible organisations or clubs. It may also be borrowed by individual firms. It may

HIGH-SPEED FLIGHT—PART III—BEYOND THE SPEED OF SOUND

Airflow pattern around a double-wedge supersonic wing section.

(By courtesy of Shell Film Unit)



not, however, be shown to audiences who pay for admission.

This second film in the series follows the same pattern as *Approaching the Speed of Sound*. It starts straight away in a high-speed wind tunnel, explaining briefly that it is using the Schlieren method of cinematography. It also demonstrates the colour code. This is a better method of introducing Schlieren than in the previous film. In this case it gives the audience a code, a convention, which allows them to orientate themselves to the method of exposition.

Switching from Schlieren to diagram, we see that certain areas on the same aerofoil are subsonic, while others are supersonic. We learn how this causes shock waves which move on the surface of the wing and how turbulence develops.

The general behaviour of air when there is a mixture of subsonic and supersonic speeds is shown. We are brought back to earth, or at least water, to show how this behaviour is related to the bow wave created when a car drives through water. The use of analogy is, on the whole, good. It lowers the intellectual tension of a complex subject to show that common everyday occurrences which we all know, follow approximately the same rules.

It was interesting, and to some extent consoling, to learn what causes supersonic bangs. When an aircraft passes Mach 1 a bow wave appears. When it pulls out of a dive and slows down, the bow and tail wave carry on. When they strike the ground they are heard as a double bang.

It is in the transonic range, through which all aircraft must pass to reach supersonic speeds, that some of the greatest problems in aircraft design arise. Some of the difficulties caused by shock waves may cause sudden loss of lift, drag, and changes in trim. This is similar to the low-speed stall and is called "Shock Stall". We see some of the terrifying weavings of an aircraft in the transonic range, such as porpoising, snaking, and Dutch roll. These, with the loss of effective controls, makes one have a tremendous respect for the high-speed pilot.

As an aircraft goes beyond its critical Mach number energy is lost as heat, this energy must be replaced constantly. The so-called "sound barrier" is due mainly to the rapid rise in drag as the aircraft is passing through the transonic range.

The diagram is even better in this part than in the first. The way in which the cross-sections of an aircraft at different points along its axis must change smoothly, is brilliantly demonstrated by taking cross-sections and animating them down on to a graph to show how they are planned to give a smooth flowing line.

The complexity of dealing with a mixed flow, which is part subsonic and part supersonic created in this speed range, is one of the greatest difficulties for the aircraft designer to overcome, and consequently for the student to understand. In order to make the Schlieren cinematography clearer and more dynamic, the film has been specially treated during processing so that the supersonic regions are a lighter green than the background colour, and the Schlieren pattern has been maintained in schematic diagrams so that the established colour code can be used consistently.

The use of the combination of actual photography with diagrammatic overlays giving formulae and arrows indicating lift and drag is effective. It could have been more effective if the arrow had been used less ubiquitously. It is a pity that the diagram designer cannot get past the bow-and-arrow age.

This film on the whole is more dramatic than the others in the series because more troubles develop in the transonic speed range. How the human mind and hand can control a machine in these conditions is almost beyond imagination. The film shows very competently how the scientist and the technician are overcoming every obstacle as it appears, and how pure research techniques are being used to investigate and solve the riddle of high-speed flight.

High-Speed Flight. Part 3: Beyond the Speed of Sound

35 mm. and 16 mm., colour, sound, running time 19 minutes. Produced by the Shell Film Unit 1959; Director, Dennis Segaller; photography, Ronald Whitehouse; animation, Archie Shaw and Leslie Davie. Technical advisers, Squadron Leader J. N. Quick, M.A., A.F.R.AE.S., R.A.F., and F. G. Irving, M.ENG., D.I.C., A.F.R.AE.S. Available on free loan to education establishments, museums, service units and other responsible organisations or clubs. It may also be borrowed by individual firms. It may not, however, be shown to audiences who pay for admission.

This third and last film in the trilogy starts excitingly with British, French, Swedish, and American supersonic aircraft in flight. Wisely it begins with a brief recapitulation of Part 2 and shows once more the arbitrary colour code chosen for the Schlieren photography. Near the beginning it also combines animated diagram with actual photography.

This film deals with the much more straightforward problems of supersonic flight. It demonstrates the problem by showing once more what happens when a single point is moving supersonically. The sound pressure waves form a round cone called the Mach cone. This diagram develops to explain what happens to the angle of this cone called the Mach angle as the Mach number increases. This is once more related to reality by demonstrating what happens when the point of a pencil is held in flowing water.

The slowing down effect of a shock wave is shown when the shock wave is at right angles to the flow. The fall in air speed to subsonic is very badly demonstrated by using the length of arrows to represent speed. This confused your reviewer for at least half a minute. The film-maker seemed to realise the confusion he had created for he followed up with an amusing model walking cow. This he used as an analogy for super- and subsonic speed. It went fast down a steep incline and slower on a shallower incline. The board and the toy cow are then used to show several other peculiarities similar to those which occur when wings are swept back. This is a fairly effective means of exposition. But, as the human mind is always seeking distraction and escape, your reviewer thought: "What an amusing toy. I wonder whether I can get it in London."

The use of analogy is undoubtedly valuable, but there is a nagging question in the mind. Is quite such a bucolic image as the cow justified? This is a mere quibble, but meditation on communication themes may produce better performance.

With relative simplicity the film goes on to show the problems and the solutions so far obtained. It is a tribute to the film, that even when tackling the most obscure and difficult questions, the slow logical approach makes one feel one has understood. Unfortunately, the different air speeds, the constantly moving shock waves and their scientific explanations, are visually so similar that after a time they become almost soporific. Never see more than one of these films on the same day!

In fact these films should be seen more than once, or they should be part of a teaching unit. This applies equally to the interested layman. For he is more likely to be left with a residual confusion.

Your reviewer saw these films with an intelligent schoolboy who will be specialising in mathematics and physics. He got the general trend, but much of the detail passed too quickly for him to note and remember. It is a great problem this. How can a film of reasonable length move at a sufficiently slow tempo to make really strong and lasting impact? One solution is to make a series of very much shorter films lasting less than ten minutes. Each one would deal with a specific, strictly limited aspect of high-speed flight. Another method would be to have a strong recapitulation of the fundamental facts at the end of each film. This has been done

in this series, but at the beginning of the second and third film. Another possible method is to make an abbreviated version of each film, cutting down on the multiplicity of examples of, for example, shock wave formation on aerofoils. It should be possible to take one example and follow it through. This method would permit laymen and beginners to see the simple version, and experts and those who have completed a course on the subject to see the present film as the summing up.

It will certainly be a great pity if such excellent films cannot be re-edited in such a form that they can be seen, and understood, by those in the technical modern schools, and those to whom "popular science" is the limit of their knowledge of things nuclear and supersonic. It might be sufficient to show how the problem has been solved with just fairly brief Schlieren sequences to show the sort of thing that happens at supersonic speeds.

After dealing fairly comprehensively with wing and general aircraft design the film ends with one of the most exciting air sequences I have seen. We see an "aerocade" of the present trend of aircraft design followed by a scientific estimate of what aircraft will look like in the future. One type has straight wings at low speed and becomes highly swept for supersonic flight. This forecast is accompanied by a clever use of electronic effects. One leaves the cinema with the feeling of pioneering and excitement, which surely is the spur to all true scientists.

L. GOULD-MARKS

December Television

One can hardly expect much science as Christmas fare, and indeed this has been the case. The really notable science broadcasting of the month has been the completion by Sir Lawrence Bragg of his six weekly series of experimental demonstrations on "The Nature of Things". His last broadcast was on crystals and, as might have been expected, was the crowning achievement. These BBC outside broadcasts from the lecture theatre of the Royal Institution were, all six of them, nothing less than elegant. Apart from the striking novelty of many of the demonstrations illustrating physical properties, there was not a single misfire, neither in the experiment nor in its capture by the camera. The perfection of broadcast of such a continuous succession of delightful close-up laboratory demonstrations, none of them easy, was a very real tribute both to the skill involved in preparing the experiments and to the excellence in production and camera work in securing the shots. Only those who have attempted the difficult art of demonstrating physical experiments in large close-up before television cameras can really appreciate the difficulties encountered. There is not much depth of focus when operating at close quarters, fore-shortening can be a deadly destructive influence, and even the correct placing of the hands to avoid obscuration of the camera viewpoint is quite a problem. The experimenter just simply cannot look at a monitor screen during his experiment, he has other things to do. In fact a good deal of jockeying and very precise placing is required even for a mere fifteen minutes of continuous experimental demonstration. The rehearsal time needed for camera placing would surprise many.

During the early part of the month the BBC gave us the second of their big broadcasts on "Life". Again Prof. Swann and Raymond Baxter played the principal roles. This broadcast dealt with the formidable problem of cancer, not the surgical approach, but concerned itself with explaining cancerous cell multiplication and its mechanism. It was much less theatrical than the previous broadcast in the series and, at least to your reviewer, was a much better broadcast. There still existed a tendency for the "breakthrough" parlance, but this time not unduly so. It was much more sober than its predecessor, but must have been heavy going for many. Some exceptionally fine cinemicrography was included.

ITV have slipped back into their old mournful routine of offering no science at all other than the curious Sunday 5.50 p.m. item, "It Can Happen Tomorrow". Just quite what this is supposed to be has always been a bit of a puzzle to your reviewer. It follows hard on the heels of the Children's Hour and your reviewer has never quite made up his mind whether this is meant for teen-agers or for adults. In the printed programme in the *TV Times* one reads weekly, below the title the caption, *"The next twenty years promise exciting advance in the scientific world. David Lutyens brings news of developments from various fields of scientific research."* This only adds to the confusion. The December 13 broadcast was certainly admirable science, fulfilling the terms of the contract, so to speak, for it dealt with the fundamental principles of the nuclear fission breeder reactor. But curiously enough the December 20 broadcast concerned itself with post office letter sorting! (Seasonable, of course.) The ability to select and sort was illustrated rather weakly with some indifferent tests on the selection of nonsense syllables. Amusing enough, certainly; perhaps of real practical importance in the economics of letter sorting, but certainly not in the remotest resembling the *TV Times* description as an exciting scientific advance. The description of a proposed adoption of a number coding to help automatic sorting is hardly worthy of the name science, much less important science.

For long past Gerald Leach ably held the fort in this regular Sunday programme. His place is at the moment being taken by David Lutyens. Mr Lutyens is an excellent television broadcaster. His detailed explanation of nuclear fission and of the mechanism of reaction in a nuclear pile was an admirably clear and delightful piece of broadcasting, deserving high commendation for its very effective clarity, compactness, and informative content. The few distinctive models employed by Mr Lutyens made all the difference to what must be after all a very mystifying process to the layman.

During Christmas week itself it would be asking too much to expect serious *live* scientific broadcasting. In fact all that was offered were two repeats by the BBC of old *Zoo Quest* films made by David Attenborough.

S. TOLANSKY

Kodak Colour Scholarships

In the use of colour photography progress has been less rapid in the United Kingdom than in the U.S.A. and the standard in America is therefore higher in such branches as portraiture, advertising, book and periodical illustration, medical and scientific work, and a host of special applications.

In an endeavour to reduce this difference, Kodak Limited decided last year to make an award annually of up to six scholarships tenable in the laboratories and studios of the Eastman Kodak Company in Rochester, New York, U.S.A. They are intended, primarily, for suitable students of photography, of either sex, from recognised schools and colleges, who are normally resident in Great Britain or Northern Ireland, and who are recommended by the principals of the schools and colleges concerned. But they are also intended for teachers of photography and for young professional photographers who can produce evidence of their ability.

Successful candidates are given approximately three months' specialised instruction during the summer or autumn. The course consists of the theory of colour photography, short courses in such subjects as photo-finishing for amateurs on a commercial scale, mechanised production of colour prints, transparencies and enlargements, photomechanical reproductions from colour transparencies and prints, and production of 16 mm. informational films in colour. The practical work includes camera operating, photography in the studio and "on location", advertising, commercial, scientific, medical, still-life, fashion and illustrative photography as well as the production of fine quality enlargements from colour negatives or positives made by the students and by eminent American colour photographers. In addition there are outside

visits to the Eastman House Museum of Photography, to the Rochester Institute of Technology—which is one of the most advanced training centres in photography and graphic arts in the United States—and to selected studios, laboratories, and exhibitions in New York City.

Kodak Limited pays the cost of the students' return passage to the U.S.A. and their fares to and from Rochester, U.S.A., and their living and incidental expenses while travelling and while residing in the United States. The allowance also provides a reasonable amount of pocket money and students are insured against illness and for other risks.

The qualifications for candidates entering from schools and colleges is, as a minimum, a standard equivalent to a first-class pass in the final examination in photography of the City and Guilds of London Institute. All candidates are required to produce reasonable details of all work, practical and theoretical, done by them during the last three years or as near to that period as possible.

The selection panel consists of a fully competent and independent body of members selected by the Ministry of Education, the Royal Photographic Society, The Institute of British Photographers, The Federation of Master Process Engravers, and the City and Guilds of London Institute. Kodak Limited is represented on the panel by an observer who is not concerned with the selection of candidates.

Kodak Limited recently staged at Kodak House, Kingsway, W.C.2, an exhibition of colour prints and transparencies by the six students (one girl and five men) who returned from America last September. These certainly demonstrated how well worth while this venture is and what can be done in an intensive three months' course.

The last date for application for the 1960 scholarships is February 29 next. Further details and the necessary application forms can be obtained from the Secretary, Kodak Limited, Kingsway, London, W.C.2.

High-speed Photography Congress

The Society of Motion Picture and Television Engineers is organising the 5th International Congress on High-speed Photography to be held in Washington, D.C., from October 16 to October 22, 1960, and the organising committee has suggested that, in order to facilitate the organisation of the Congress, it would be desirable that intending authors should present their papers through their national delegate.

The national delegate for the United Kingdom is Dr R. F. Saxe, Hon. Secretary, National Committee for High-speed Photography, Queen Mary College, Mile End Road, London, E.1, who will be pleased to receive notice of suggested contributions and from whom "Preliminary Forms for Authors" are available.

The organising committee of the Congress have stated that summaries must be received by February 16, 1960, abstracts by May 16, 1960, and manuscripts by July 16, 1960.

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